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**Xu et al.**

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(54) **METHODS AND APPARATUS FOR TDD RECONFIGURATION**

(71) Applicant: **QUALCOMM Incorporated**, San Diego, CA (US)

(72) Inventors: **Hao Xu**, San Diego, CA (US); **Wanshi Chen**, San Diego, CA (US); **Peter Gaal**, San Diego, CA (US); **Stefan Geirhofer**, San Diego, CA (US)

(73) Assignee: **QUALCOMM Incorporated**, San Diego, CA (US)

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(51) **Int. Cl.**

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|---|---|
| ***H04J 3/16*** | (2006.01) |
| ***H04W 72/04*** | (2009.01) |
| ***H04L 1/00*** | (2006.01) |
| ***H04L 1/18*** | (2006.01) |
| ***H04L 5/00*** | (2006.01) |
| ***H04L 5/14*** | (2006.01) |

(52) **U.S. Cl.**

CPC ..... ***H04W 72/0406*** (2013.01); ***H04L 1/0026*** (2013.01); ***H04L 1/0027*** (2013.01); ***H04L 1/1845*** (2013.01); ***H04L 5/001*** (2013.01); ***H04L 5/1469*** (2013.01); *H04L 1/0003* (2013.01); *H04L 1/0009* (2013.01); *H04L 5/0048* (2013.01); *H04L 5/0053* (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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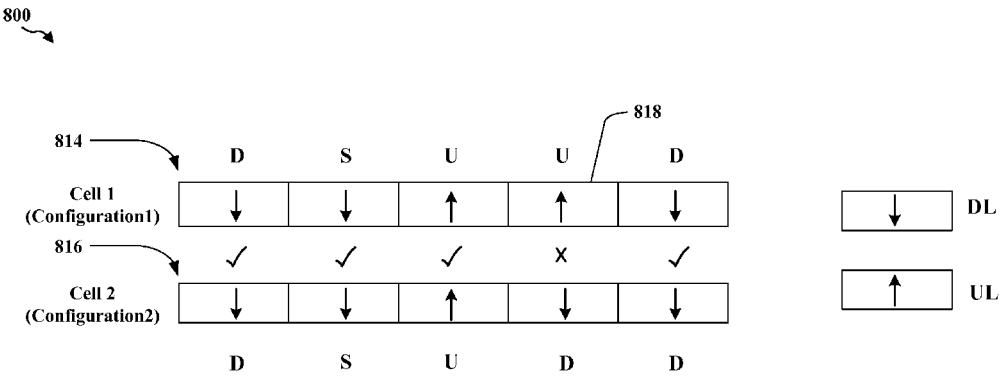
*Primary Examiner* — Kevin C Harper

(74) *Attorney, Agent, or Firm* — Arent Fox LLP

(57) **ABSTRACT**

Transmission of control data by a user equipment (UE) in circumstances following a TDD subframe reconfiguration from an evolved node B (eNB) may result in a conflict with a scheduled transmission of the control data. In one example, a UE may modify periodicity, content, priority, or other aspects of channel state information (CSI) or sounding reference signals (SRS) to resolve any conflicts resulting from a TDD subframe reconfiguration and to ensure transmission of the CSI or SRS. In another example, a UE may detect a hybrid automatic repeat request (HARQ) conflict resulting from a TDD subframe reconfiguration. In such example, the UE may determine and apply a HARQ soft buffer size for a HARQ process or determine and apply a codebook size for a HARQ process in carrier aggregation to resolve such HARQ conflict.

**35 Claims, 15 Drawing Sheets**



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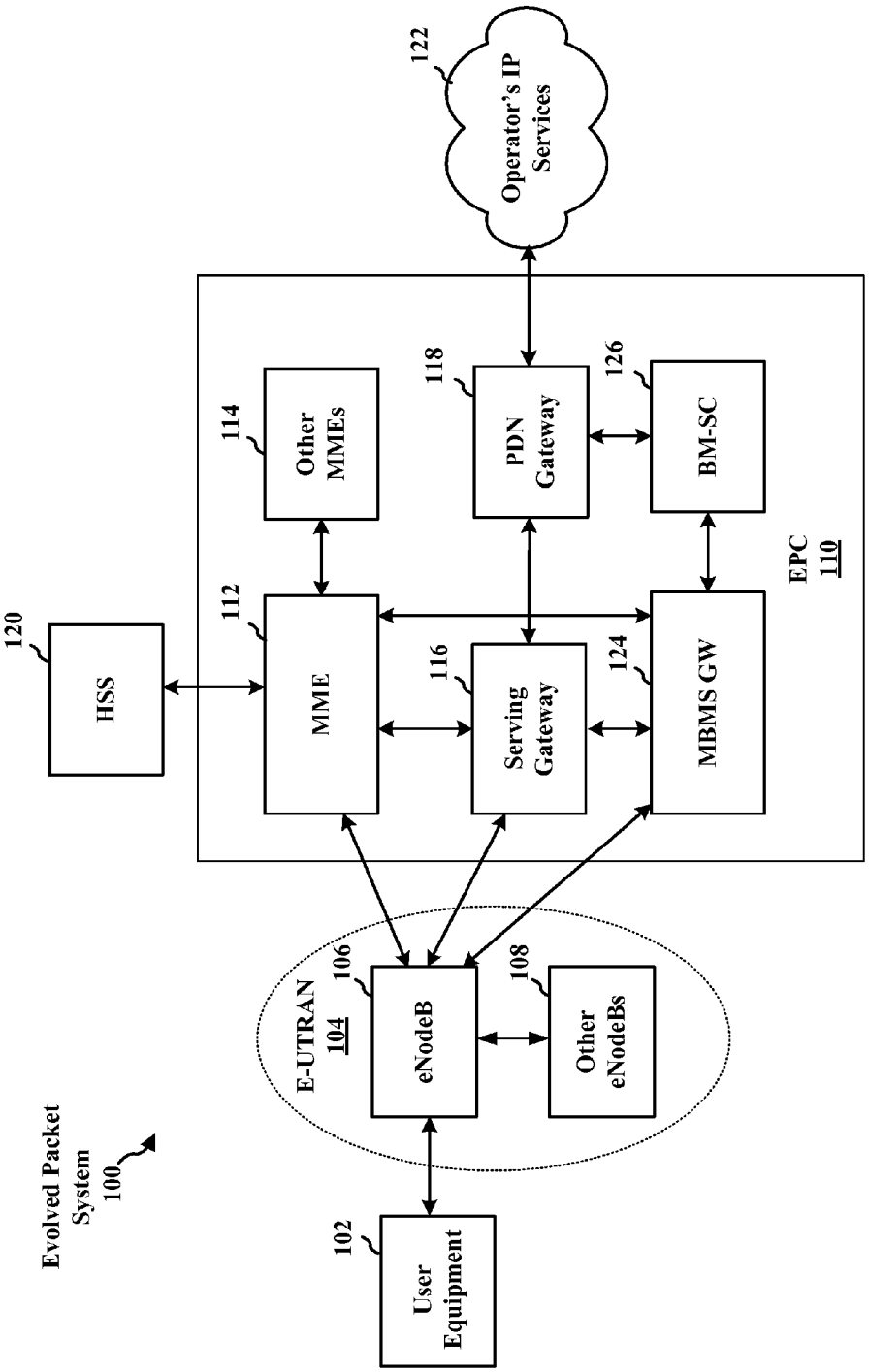
Evolved Packet System
100
User Equipment
102
E-UTRAN
104
eNodeB
106
Other eNodeBs
108
HSS
120
MME
112
Other MMEs
114
Serving Gateway
116
PDN Gateway
118
MBMS GW
124
BM-SC
126
EPC
110
Operator's IP Services
122

FIG. 1

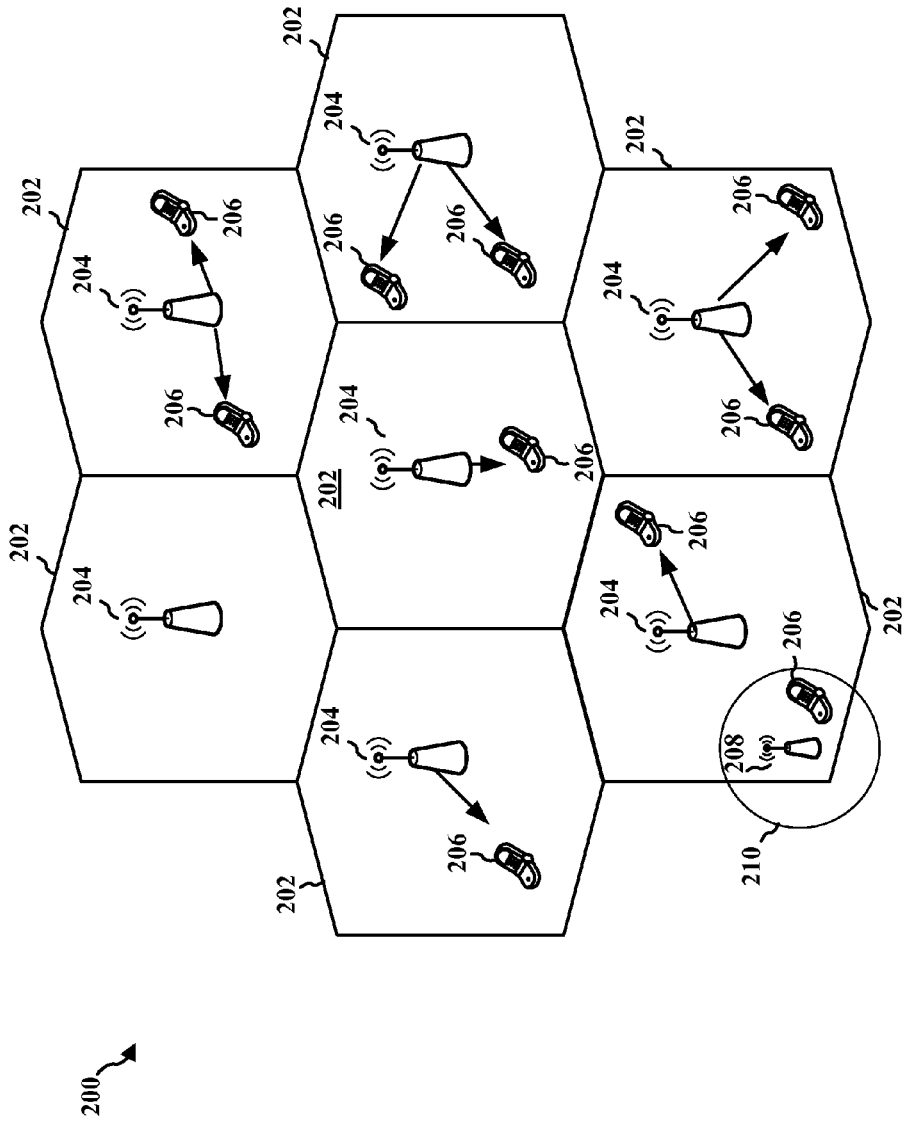


FIG. 2

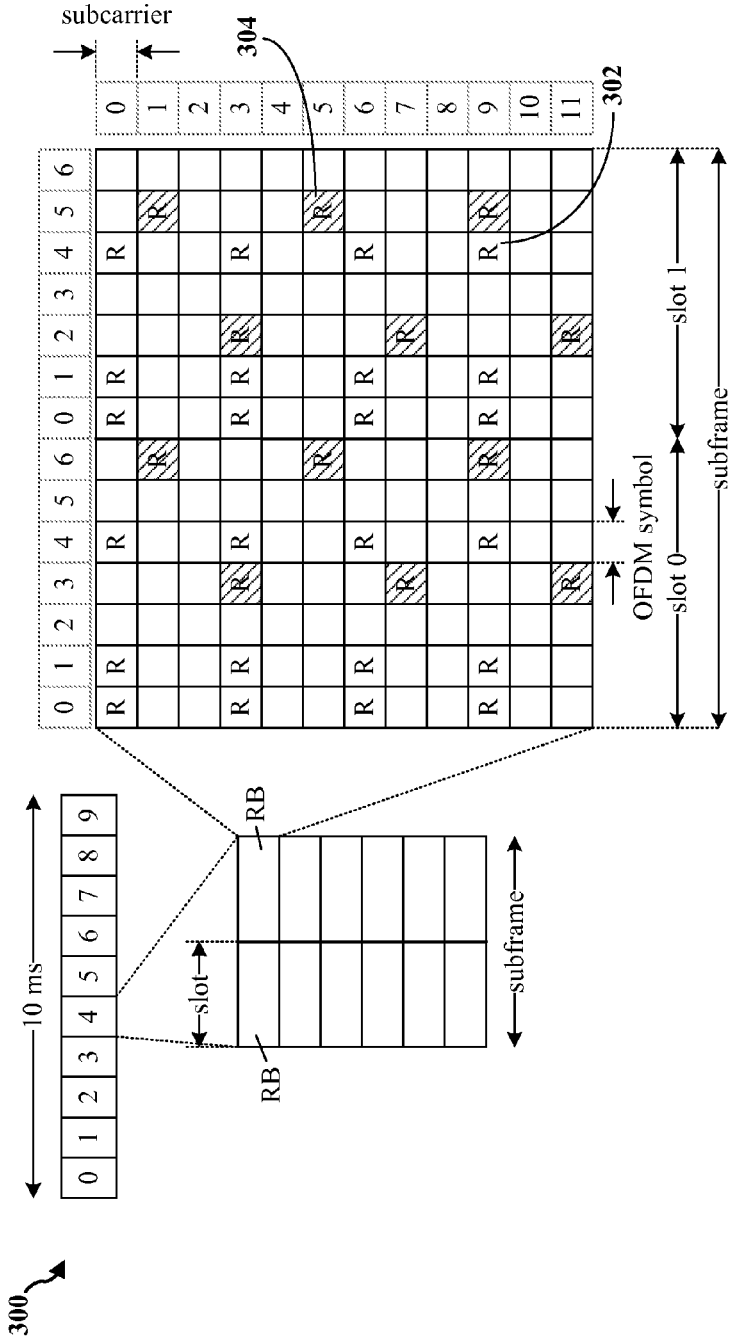
300
10 ms
slot
RB
RB
subframe
subcarrier
304
302
OFDM symbol
slot 0
slot 1
subframe

FIG. 3

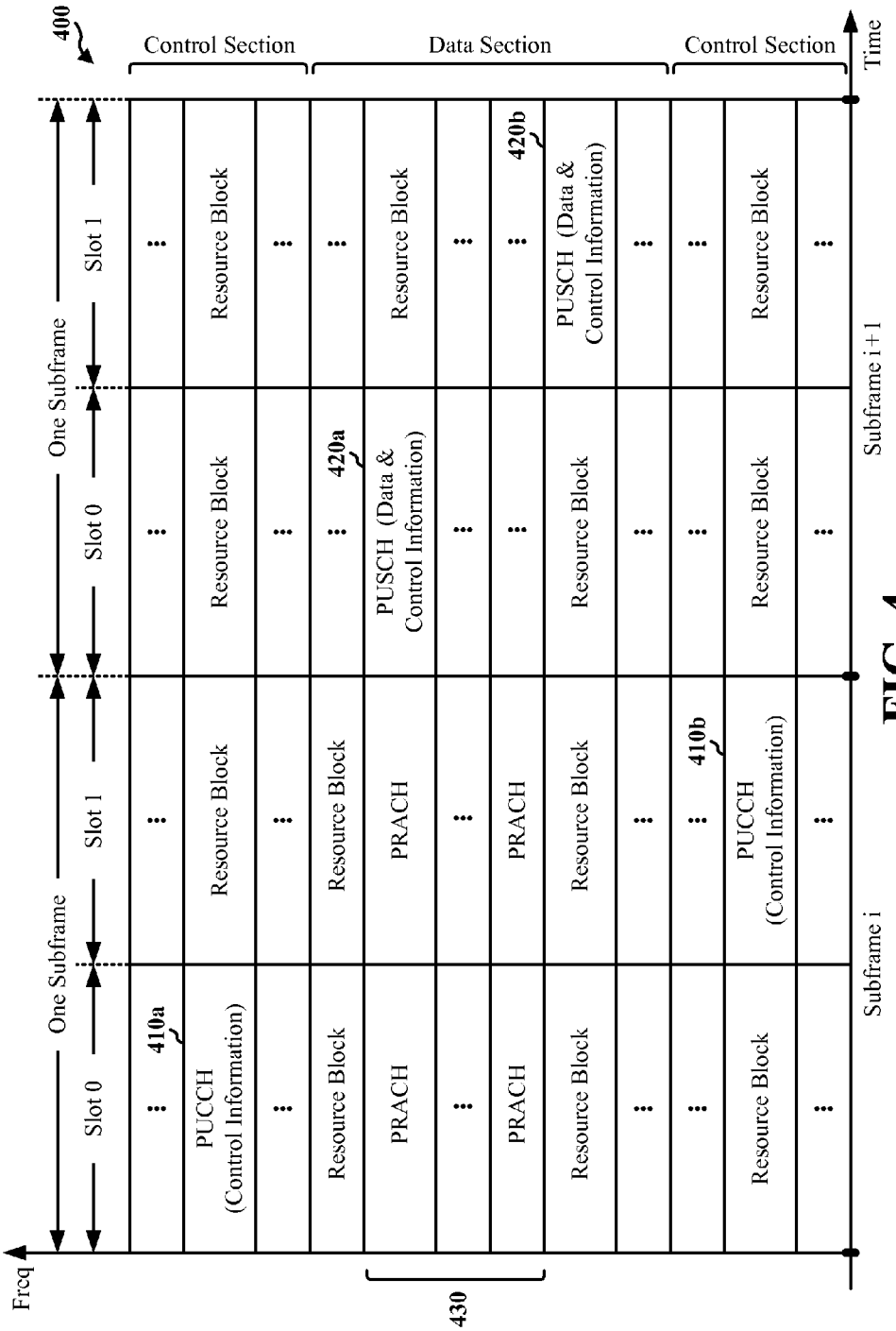
400
Control Section
Data Section
Control Section
Time
Freq
One Subframe
Slot 0
Slot 1
One Subframe
Slot 0
Slot 1
410a
PUCCH (Control Information)
Resource Block
420a
PUSCH (Data & Control Information)
420b
PUSCH (Data & Control Information)
PRACH
430
410b
PUCCH (Control Information)
Subframe i
Subframe i+1

FIG. 4

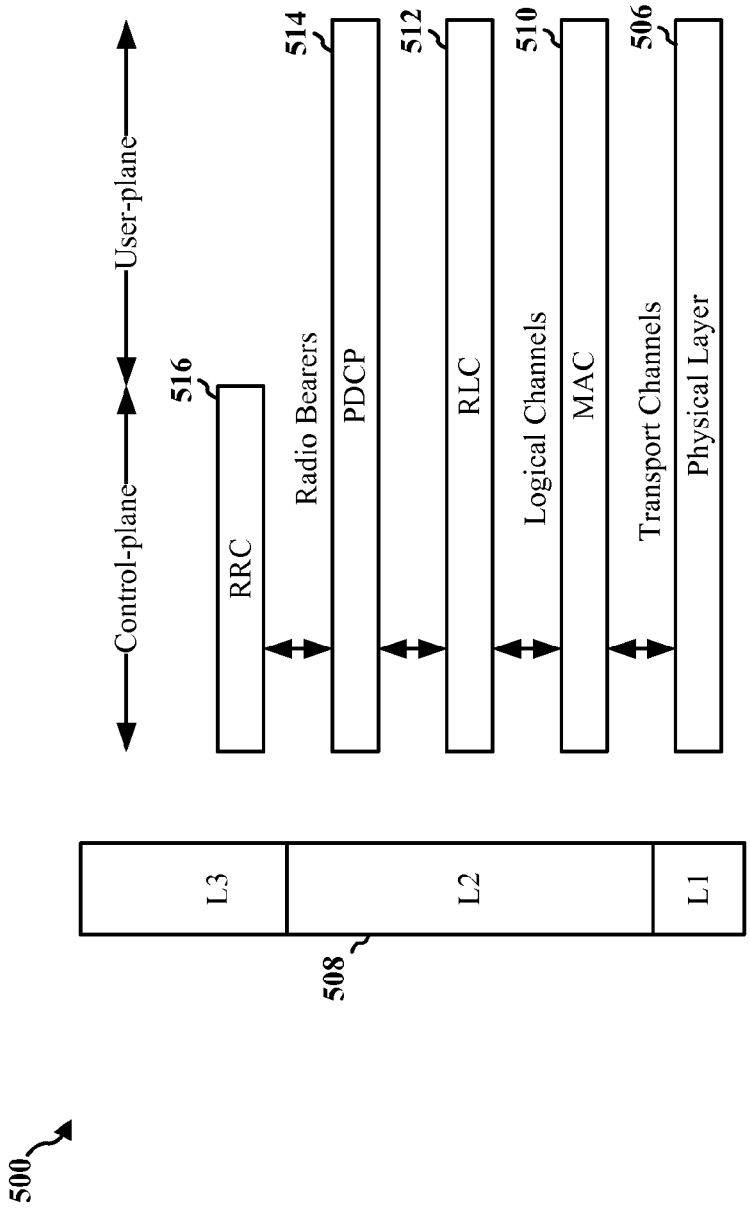
500
L3
L2
L1
508
Control-plane
User-plane
RRC
516
Radio Bearers
PDCP
514
RLC
512
Logical Channels
MAC
510
Transport Channels
Physical Layer
506

FIG. 5

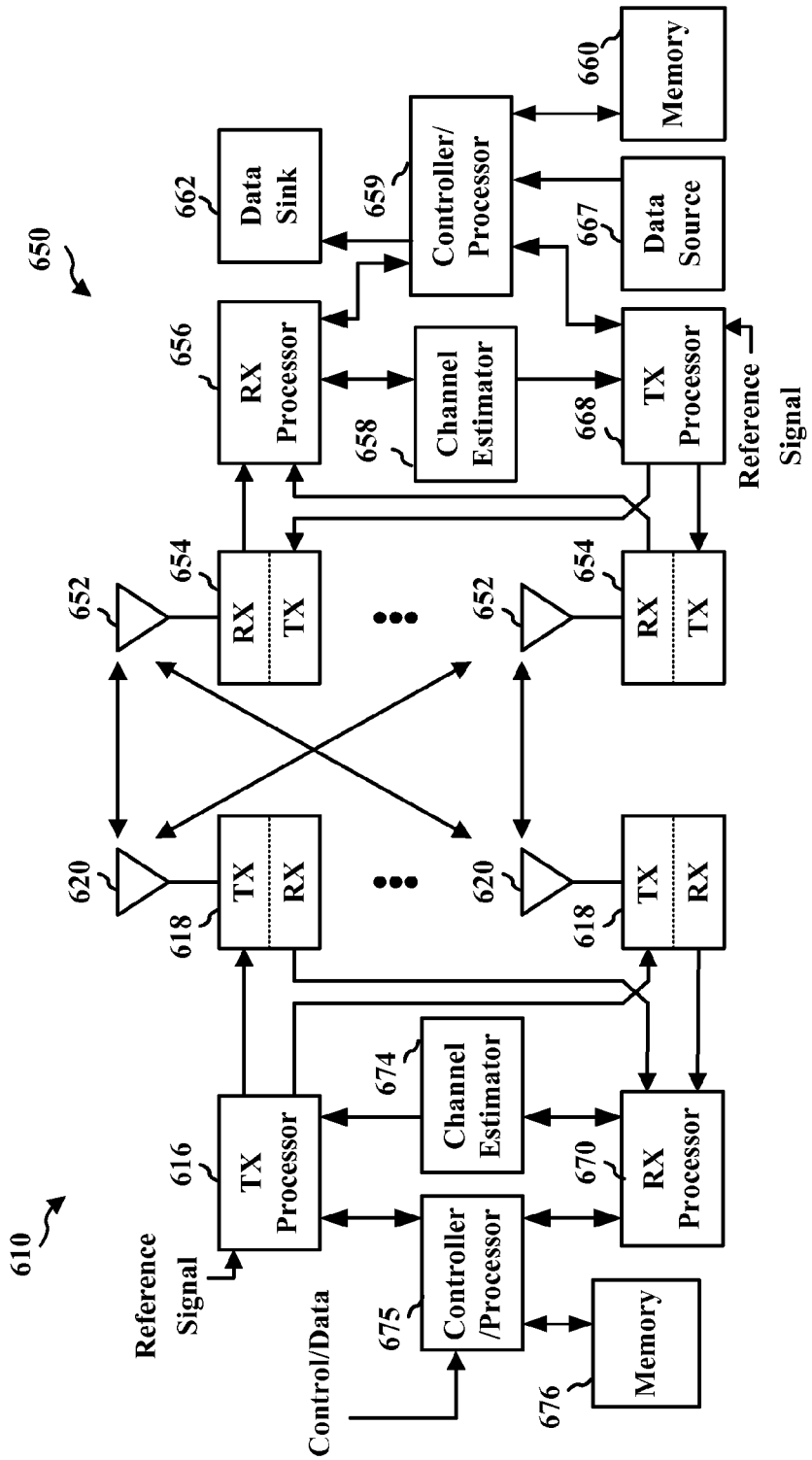
650
662
Data Sink
659
Controller/ Processor
660
Memory
667
Data Source
656
RX Processor
658
Channel Estimator
668
TX Processor
Reference Signal
652
654
RX
TX
620
618
610
616
TX Processor
674
Channel Estimator
670
RX Processor
Reference Signal
Control/Data
675
Controller /Processor
676
Memory

FIG. 6

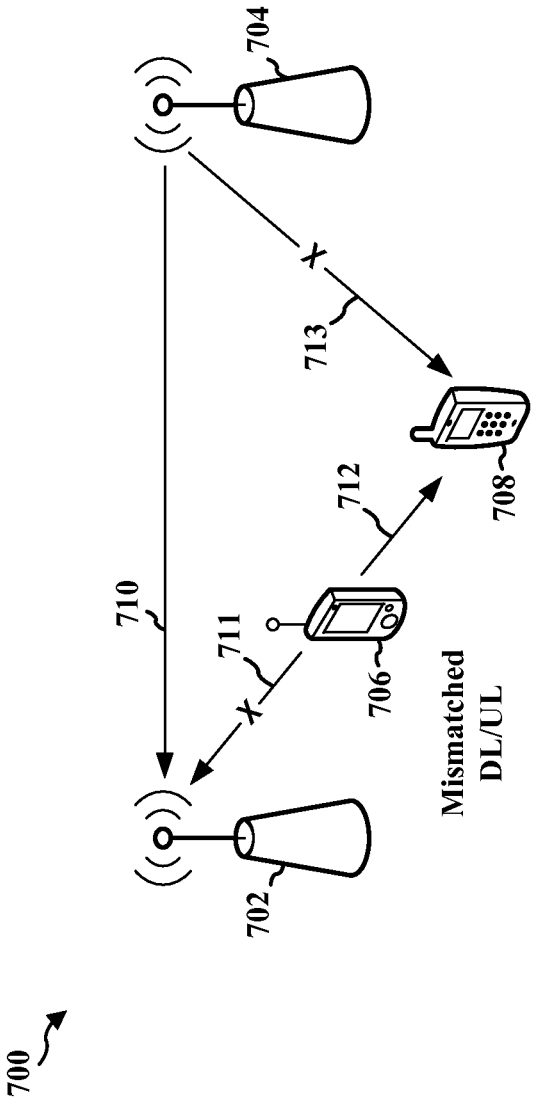


FIG. 7

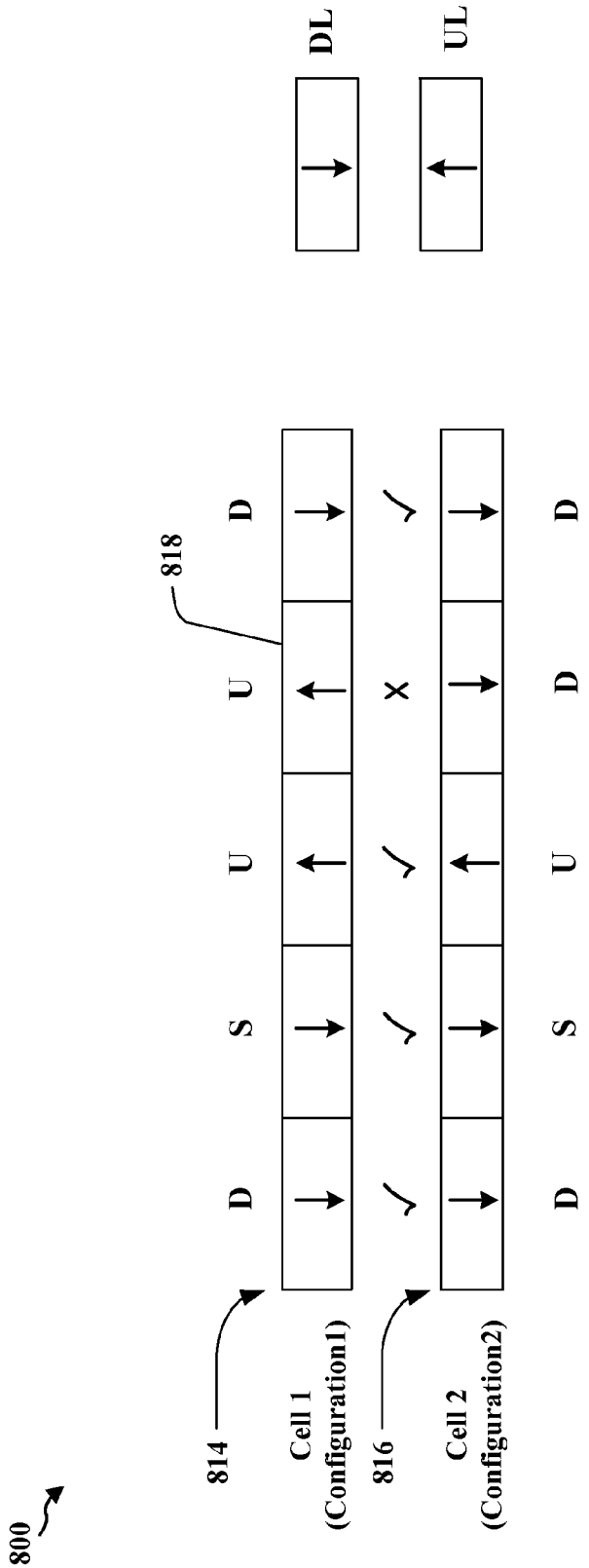
800
814
Cell 1
(Configuration1)
D
S
U
U
U
D
818
816
Cell 2
(Configuration2)
D
S
U
D
X
D
DL
UL

FIG. 8

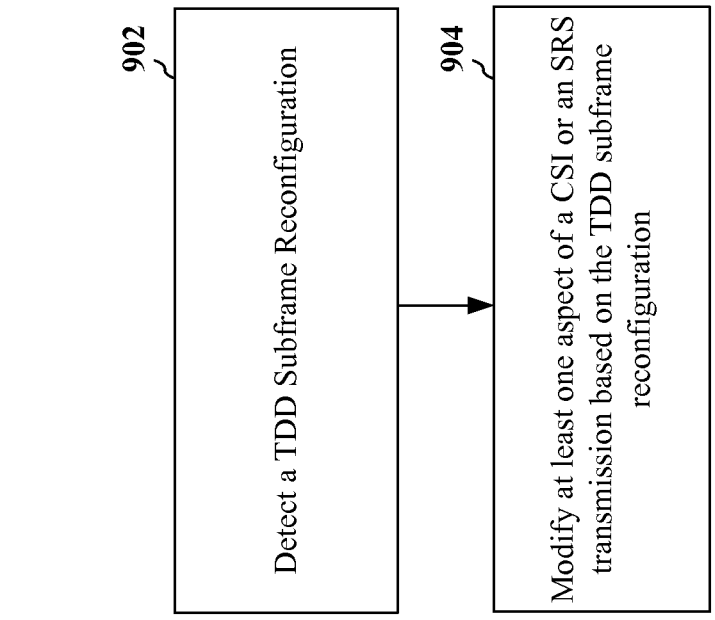
902
Detect a TDD Subframe Reconfiguration
904
Modify at least one aspect of a CSI or an SRS transmission based on the TDD subframe reconfiguration
900

FIG. 9

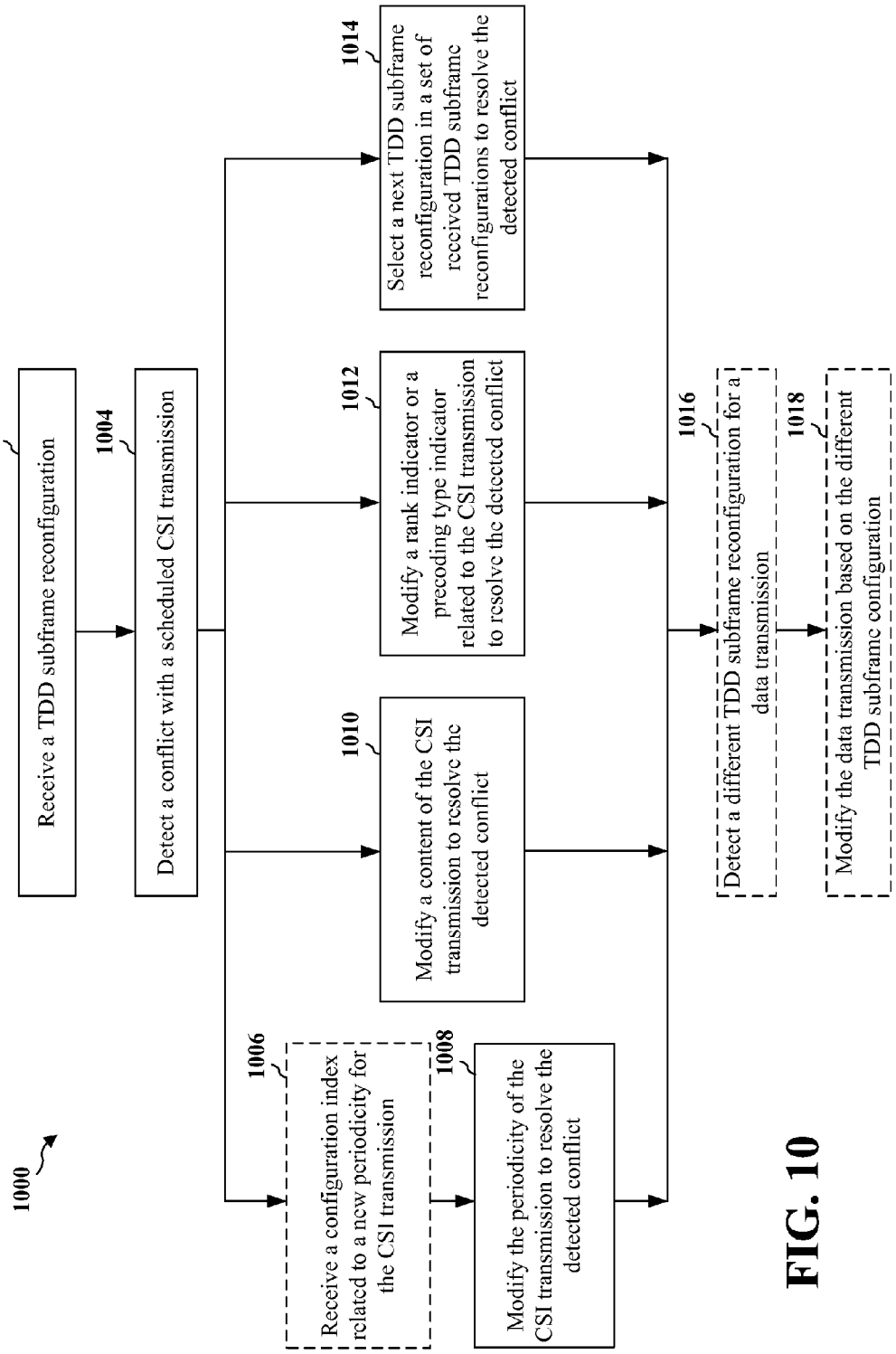
1000
1002
Receive a TDD subframe reconfiguration
1004
Detect a conflict with a scheduled CSI transmission
1006
Receive a configuration index related to a new periodicity for the CSI transmission
1008
Modify the periodicity of the CSI transmission to resolve the detected conflict
1010
Modify a content of the CSI transmission to resolve the detected conflict
1012
Modify a rank indicator or a precoding type indicator related to the CSI transmission to resolve the detected conflict
1014
Select a next TDD subframe reconfiguration in a set of received TDD subframe reconfigurations to resolve the detected conflict
1016
Detect a different TDD subframe reconfiguration for a data transmission
1018
Modify the data transmission based on the different TDD subframe configuration

FIG. 10

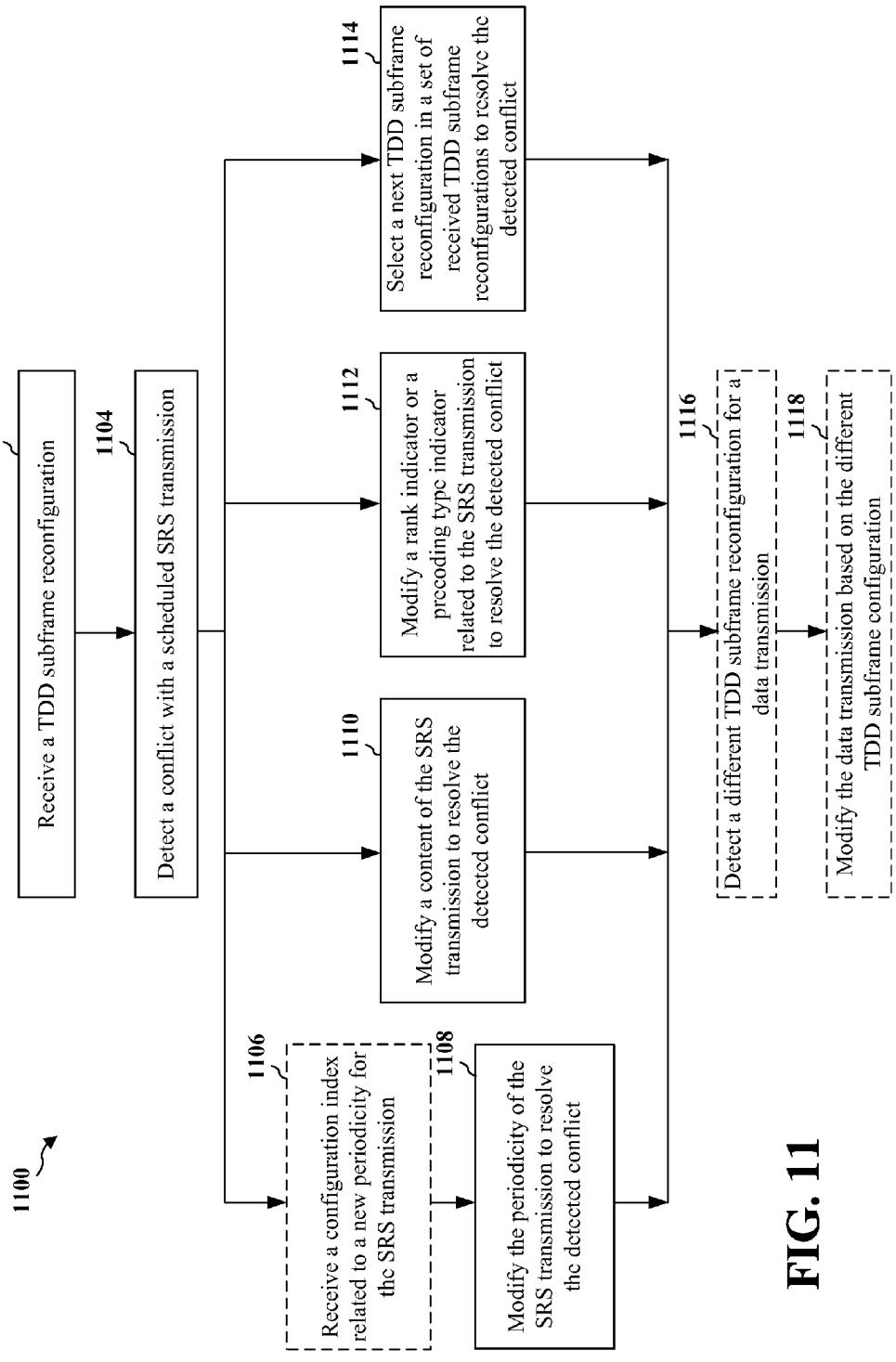
1100
1102
Receive a TDD subframe reconfiguration
1104
Detect a conflict with a scheduled SRS transmission
1106
Receive a configuration index related to a new periodicity for the SRS transmission
1108
Modify the periodicity of the SRS transmission to resolve the detected conflict
1110
Modify a content of the SRS transmission to resolve the detected conflict
1112
Modify a rank indicator or a precoding type indicator related to the SRS transmission to resolve the detected conflict
1114
Select a next TDD subframe reconfiguration in a set of received TDD subframe reconfigurations to resolve the detected conflict
1116
Detect a different TDD subframe reconfiguration for a data transmission
1118
Modify the data transmission based on the different TDD subframe configuration

FIG. 11

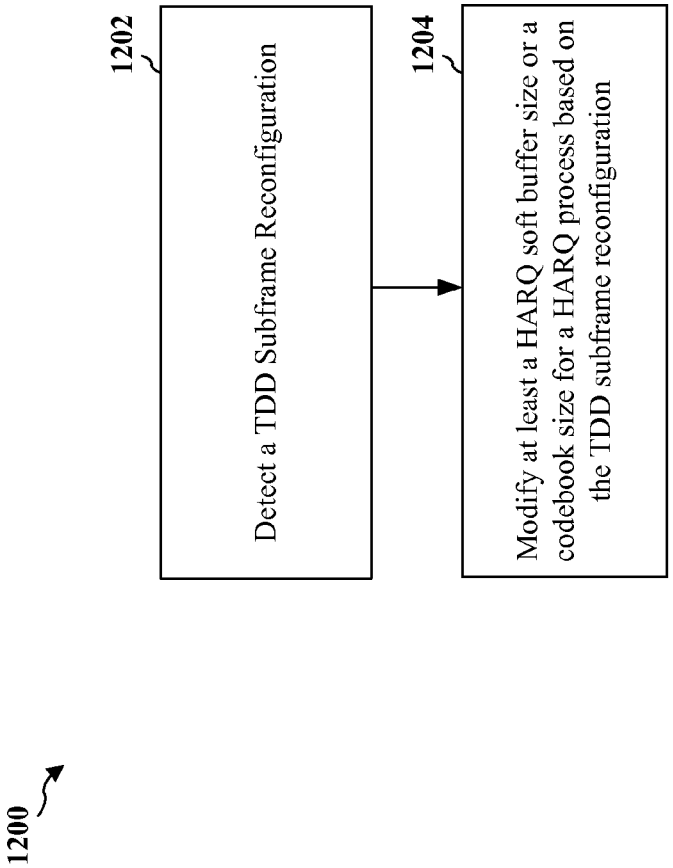
1200
1202
Detect a TDD Subframe Reconfiguration
1204
Modify at least a HARQ soft buffer size or a codebook size for a HARQ process based on the TDD subframe reconfiguration

FIG. 12

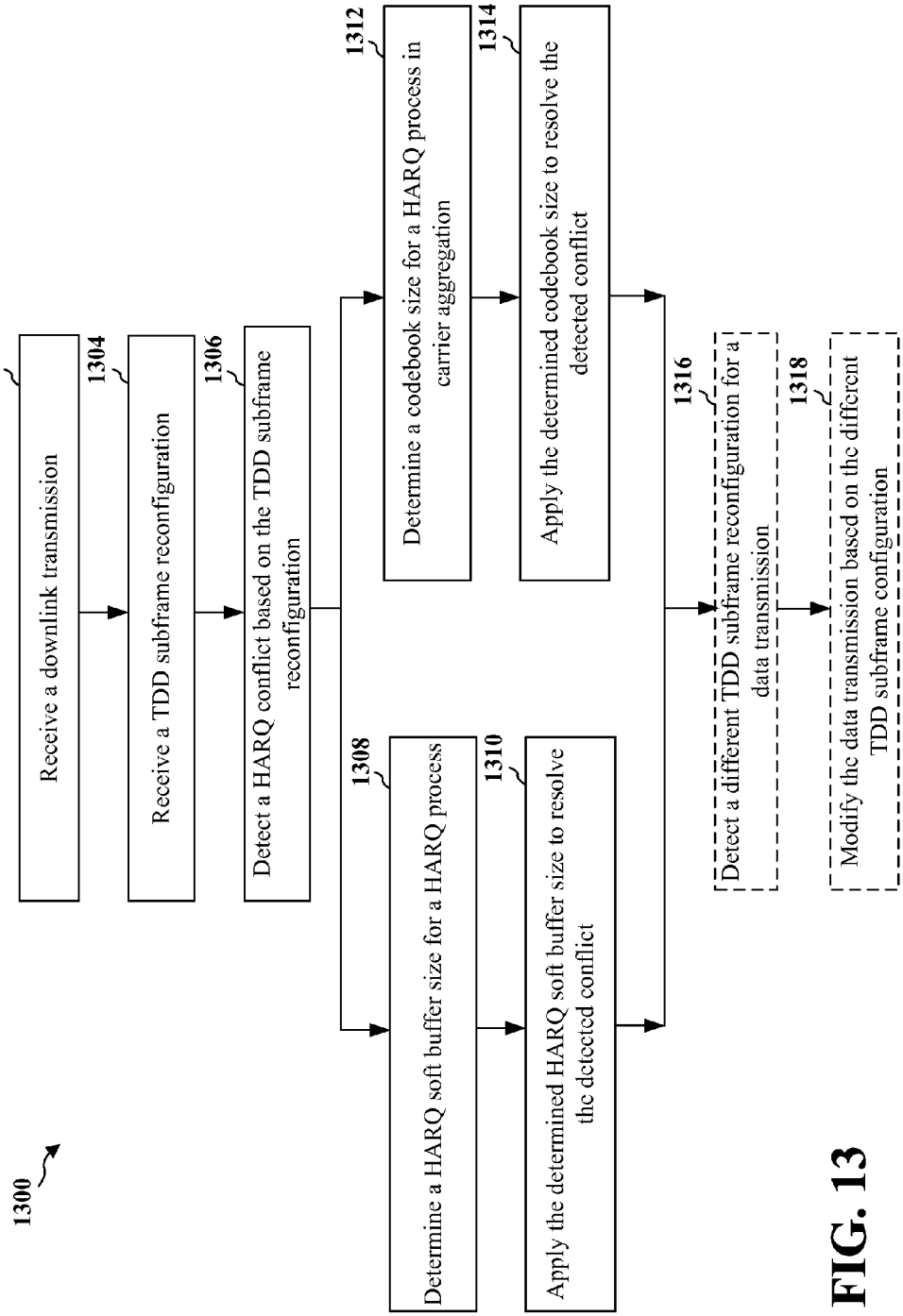
1300
1302
Receive a downlink transmission
1304
Receive a TDD subframe reconfiguration
1306
Detect a HARQ conflict based on the TDD subframe reconfiguration
1308
Determine a HARQ soft buffer size for a HARQ process
1310
Apply the determined HARQ soft buffer size to resolve the detected conflict
1312
Determine a codebook size for a HARQ process in carrier aggregation
1314
Apply the determined codebook size to resolve the detected conflict
1316
Detect a different TDD subframe reconfiguration for a data transmission
1318
Modify the data transmission based on the different TDD subframe configuration

FIG. 13

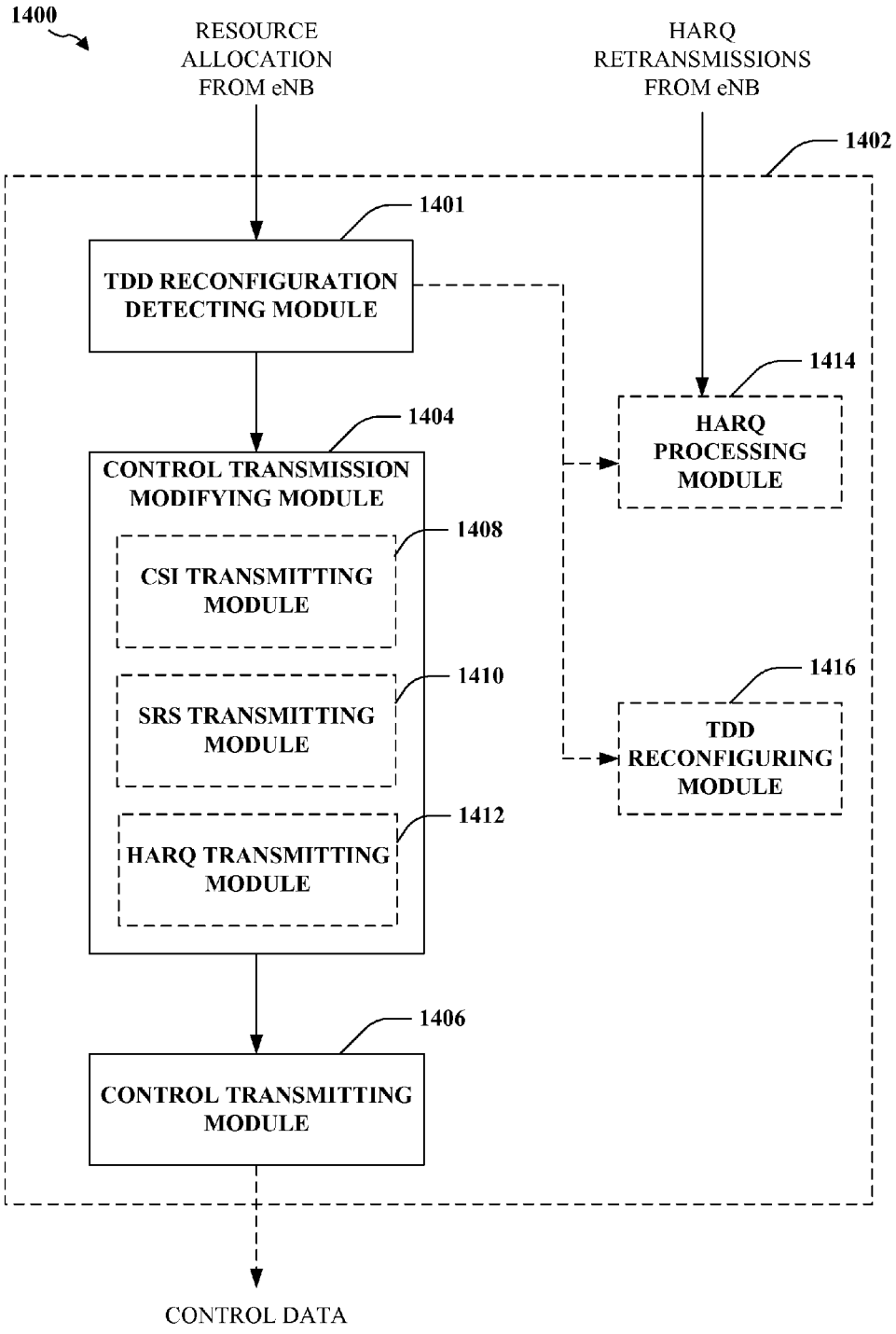
1400
RESOURCE ALLOCATION FROM eNB
HARQ RETRANSMISSIONS FROM eNB
1402
1401
TDD RECONFIGURATION DETECTING MODULE
1414
HARQ PROCESSING MODULE
1404
CONTROL TRANSMISSION MODIFYING MODULE
1408
CSI TRANSMITTING MODULE
1410
SRS TRANSMITTING MODULE
1416
TDD RECONFIGURING MODULE
1412
HARQ TRANSMITTING MODULE
1406
CONTROL TRANSMITTING MODULE
CONTROL DATA

FIG. 14

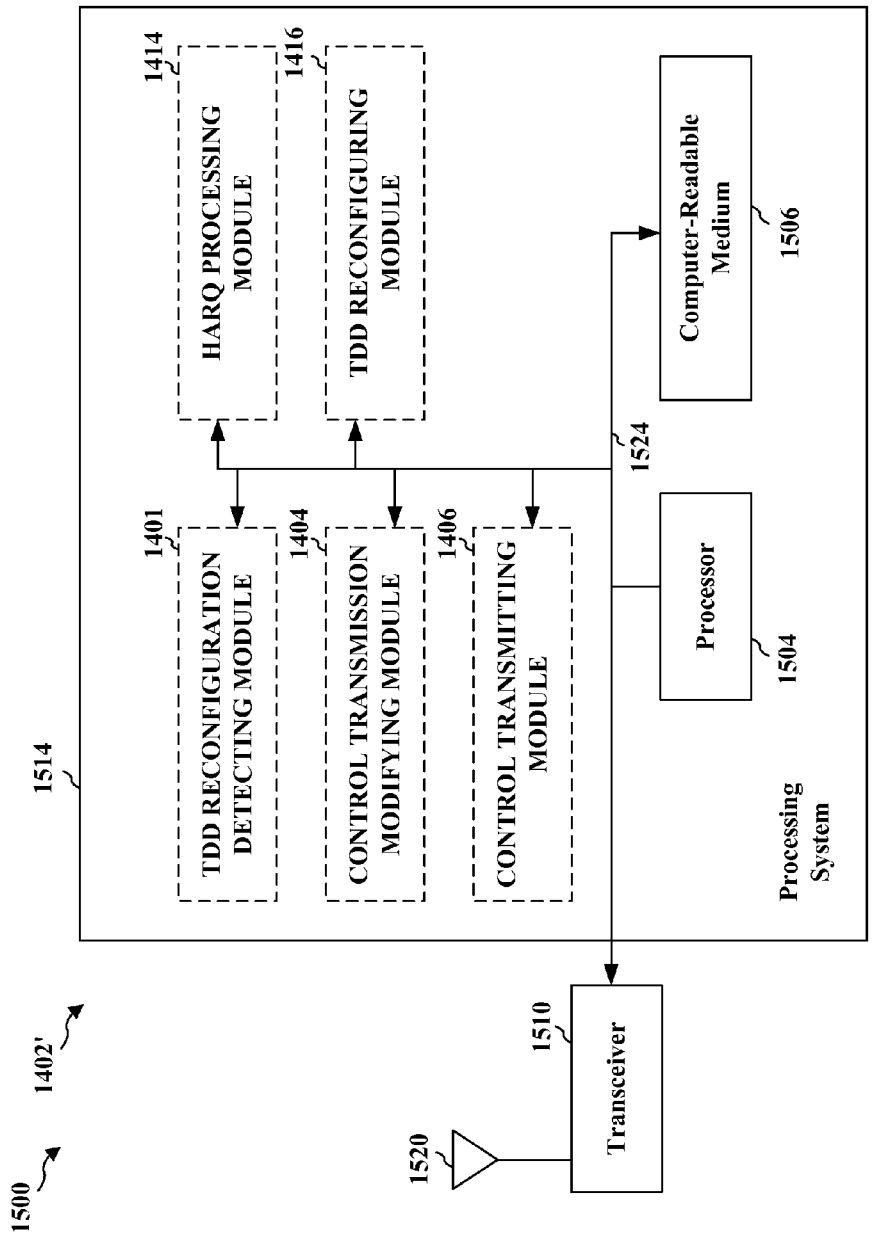
1500
1402'
1514
1401
TDD RECONFIGURATION DETECTING MODULE
1404
CONTROL TRANSMISSION MODIFYING MODULE
1406
CONTROL TRANSMITTING MODULE
1414
HARQ PROCESSING MODULE
1416
TDD RECONFIGURING MODULE
Processing System
1504
Processor
1506
Computer-Readable Medium
1524
1510
Transceiver
1520

FIG. 15

# METHODS AND APPARATUS FOR TDD RECONFIGURATION

## CROSS-REFERENCE TO RELATED APPLICATION(S)

This application claims the benefit of U.S. Provisional Application Ser. No. 61/639,737, entitled "METHODS AND APPARATUS FOR TDD RECONFIGURATION" and filed on Apr. 27, 2012, which is expressly incorporated by reference herein in its entirety.

## BACKGROUND

1. Field

The present disclosure relates generally to communication systems, and more particularly to providing adaptive time division duplexing resource configurations.

2. Background

Wireless communication systems are widely deployed to provide various types of communication content such as, for example, voice, data, and so on. Typical wireless communication systems may be multiple-access systems capable of supporting communication with multiple users by sharing available system resources (e.g., bandwidth, transmit power, . . . ). Examples of such multiple-access systems may include code division multiple access (CDMA) systems, time division multiple access (TDMA) systems, frequency division multiple access (FDMA) systems, orthogonal frequency division multiple access (OFDMA) systems, and the like. Additionally, the systems can conform to specifications such as third generation partnership project (3GPP) (e.g., 3GPP LTE (Long Term Evolution)/LTE-Advanced), ultra mobile broadband (UMB), evolution data optimized (EV-DO), etc.

Generally, wireless multiple-access communication systems may simultaneously support communication for multiple mobile devices. Each mobile device may communicate with one or more base stations via transmissions on forward and reverse links. The forward link (or downlink) refers to the communication link from base stations to mobile devices, and the reverse link (or uplink) refers to the communication link from mobile devices to base stations. Further, communications between mobile devices and base stations may be established via single-input single-output (SISO) systems, multiple-input single-output (MISO) systems, multiple-input multiple-output (MIMO) systems, and so forth.

Base stations can configure time division duplexing (TDD) resources for communicating over the uplink and downlink with one or more mobile devices according to an available subframe configuration. In particular, the base station and mobile devices are configured with information of the subframe configurations, which can specify whether a given subframe is used for uplink, downlink, or special (e.g., uplink and/or downlink) communications. Thus, given a specific configuration, the base station and mobile devices can determine whether to transmit or receive data over a given operating frequency based on a selected subframe configuration for the communications. Selection of subframe configurations, however, can be adaptive, meaning that for given communications, the subframe configuration can be different (e.g., a subframe configuration with more downlink transmission opportunities can be chosen for multimedia applications). Allowing such selection of subframe configurations, however, can lead to interference scenarios among base stations or mobile devices and/or conflict for certain communications where a period for transmitting the communications falls on a scheduled subframe for receiving communications in the new subframe configuration.



## SUMMARY

The following presents a simplified summary of one or more aspects in order to provide a basic understanding of such aspects. This summary is not an extensive overview of all contemplated aspects, and is intended to neither identify key or critical elements of all aspects nor delineate the scope of any or all aspects. Its sole purpose is to present some concepts of one or more aspects in a simplified form as a prelude to the more detailed description that is presented later.

Described herein are various aspects related to ensuring transmission of control data by a user equipment (UE) in circumstances when a TDD subframe reconfiguration from an evolved node B (eNB) results in a conflict with a scheduled transmission of the control data. In one example, a UE may modify periodicity, content, priority, or other aspects of channel state information (C SI) or sounding reference signals (SRS) to resolve any conflicts resulting from a TDD subframe reconfiguration and to ensure transmission of the CSI or SRS. In another example, a UE may detect a hybrid automatic repeat request (HARQ) conflict resulting from a TDD subframe reconfiguration. In such example, the UE may determine and apply a HARQ soft buffer size for a HARQ process or determine and apply a codebook size for a HARQ process in carrier aggregation to resolve such HARQ conflict. In other examples, different TDD subframe reconfigurations can be selected where a conflict is detected by the current TDD subframe configuration.

In an aspect of the disclosure, a method, a computer program product, and an apparatus are provided. The apparatus may be a UE. The UE may detect a TDD subframe reconfiguration and modify at least one aspect of a CSI or SRS transmission based on the TDD subframe reconfiguration.

In another aspect of the disclosure, a method, a computer program product, and an apparatus are provided. The apparatus may be a UE. The UE may detect a TDD subframe reconfiguration and modify at least a HARQ soft buffer size or a codebook size for a HARQ process based on the TDD subframe reconfiguration.

To the accomplishment of the foregoing and related ends, the one or more aspects comprise the features hereinafter fully described and particularly pointed out in the claims. The following description and the annexed drawings set forth in detail certain illustrative features of the one or more aspects. These features are indicative, however, of but a few of the various ways in which the principles of various aspects may be employed, and this description is intended to include all such aspects and their equivalents.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram illustrating an example of a network architecture.

FIG. **2** is a diagram illustrating an example of an access network.

FIG. **3** is a diagram illustrating an example of a DL frame structure in LTE.

FIG. **4** is a diagram illustrating an example of an UL frame structure in LTE.

FIG. **5** is a diagram illustrating an example of a radio protocol architecture for the user and control planes.

FIG. **6** is a diagram illustrating an example of an evolved Node B (eNB) and user equipment (UE) in an access network.

FIG. **7** illustrates an example system that can exhibit eNB-to-eNB interference or UE-to-UE interference.

FIG. **8** is a diagram illustrating TDD subframe configurations.

FIG. **9** is a flow chart of a method of wireless communication.

FIG. **10** is a flow chart of a method of wireless communication.

FIG. **11** is a flow chart of a method of wireless communication.

FIG. **12** is a flow chart of a method of wireless communication.

FIG. **13** is a flow chart of a method of wireless communication.

FIG. **14** illustrates an example apparatus for mitigating conflicts in TDD subframe reconfiguration.

FIG. **15** is a diagram illustrating an example of a hardware implementation for an apparatus employing a processing system.

## DETAILED DESCRIPTION

The detailed description set forth below in connection with the appended drawings is intended as a description of various configurations and is not intended to represent the only configurations in which the concepts described herein may be practiced. The detailed description includes specific details for the purpose of providing a thorough understanding of various concepts. However, it will be apparent to those skilled in the art that these concepts may be practiced without these specific details. In some instances, well known structures and components are shown in block diagram form in order to avoid obscuring such concepts.

Several aspects of telecommunication systems will now be presented with reference to various apparatus and methods. These apparatus and methods will be described in the following detailed description and illustrated in the accompanying drawings by various blocks, modules, components, circuits, steps, processes, algorithms, etc. (collectively referred to as "elements"). These elements may be implemented using electronic hardware, computer software, or any combination thereof. Whether such elements are implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system.

By way of example, an element, or any portion of an element, or any combination of elements may be implemented with a "processing system" that includes one or more processors. Examples of processors include microprocessors, microcontrollers, digital signal processors (DSPs), field programmable gate arrays (FPGAs), programmable logic devices (PLDs), state machines, gated logic, discrete hardware circuits, and other suitable hardware configured to perform the various functionality described throughout this disclosure. One or more processors in the processing system may execute software. Software shall be construed broadly to mean instructions, instruction sets, code, code segments, program code, programs, subprograms, software modules, applications, software applications, software packages, routines, subroutines, objects, executables, threads of execution, procedures, functions, etc., whether referred to as software, firmware, middleware, microcode, hardware description language, or otherwise.

Accordingly, in one or more exemplary embodiments, the functions described may be implemented in hardware, software, firmware, or any combination thereof. If implemented in software, the functions may be stored on or encoded as one or more instructions or code on a computer-readable medium. Computer-readable media includes computer storage media. Storage media may be any available media that can be accessed by a computer. By way of example, and not limitation, such computer-readable media can comprise RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium that can be used to carry or store desired program code in the form of instructions or data structures and that can be accessed by a computer. Disk and disc, as used herein, includes compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), and floppy disk where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Combinations of the above should also be included within the scope of computer-readable media.

FIG. **1** is a diagram illustrating an LTE network architecture **100**. The LTE network architecture **100** may be referred to as an Evolved Packet System (EPS) **100**. The EPS **100** may include one or more user equipment (UE) **102**, an Evolved UMTS Terrestrial Radio Access Network (E-UTRAN) **104**, an Evolved Packet Core (EPC) **110**, a Home Subscriber Server (HSS) **120**, and an Operator's Internet Protocol (IP) Services **122**. The EPS can interconnect with other access networks, but for simplicity those entities/interfaces are not shown. As shown, the EPS provides packet-switched services, however, as those skilled in the art will readily appreciate, the various concepts presented throughout this disclosure may be extended to networks providing circuit-switched services.

The E-UTRAN includes the evolved Node B (eNB) **106** and other eNBs **108**. The eNB **106** provides user and control planes protocol terminations toward the UE **102**. The eNB **106** may be connected to the other eNBs **108** via a backhaul (e.g., an X2 interface). The eNB **106** may also be referred to as a base station, a Node B, an access point, a base transceiver station, a radio base station, a radio transceiver, a transceiver function, a basic service set (BSS), an extended service set (ESS), or some other suitable terminology. The eNB **106** provides an access point to the EPC **110** for a UE **102**. Examples of UEs **102** include a cellular phone, a smart phone, a session initiation protocol (SIP) phone, a laptop, a personal digital assistant (PDA), a satellite radio, a global positioning system, a multimedia device, a video device, a digital audio player (e.g., MP3 player), a camera, a game console, a tablet, or any other similar functioning device. The UE **102** may also be referred to by those skilled in the art as a mobile station, a subscriber station, a mobile unit, a subscriber unit, a wireless unit, a remote unit, a mobile device, a wireless device, a wireless communications device, a remote device, a mobile subscriber station, an access terminal, a mobile terminal, a wireless terminal, a remote terminal, a handset, a user agent, a mobile client, a client, or some other suitable terminology.

The eNB **106** is connected to the EPC **110**. The EPC **110** includes a Mobility Management Entity (MME) **112**, other MMEs **114**, a Serving Gateway **116**, a Multimedia Broadcast Multicast Service (MBMS) Gateway **124**, a Broadcast Multicast Service Center (BM-SC) **126**, and a Packet Data Network (PDN) Gateway **118**. The MME **112** is the control node that processes the signaling between the UE **102** and

the EPC **110**. Generally, the MME **112** provides bearer and connection management. All user IP packets are transferred through the Serving Gateway **116**, which itself is connected to the PDN Gateway **118**. The PDN Gateway **118** provides UE IP address allocation as well as other functions. The PDN Gateway **118** is connected to the Operator's IP Services **122**. The Operator's IP Services **122** may include the Internet, an intranet, an IP Multimedia Subsystem (IMS), and a PS Streaming Service (PSS). The BM-SC **126** may provide functions for MBMS user service provisioning and delivery. The BM-SC **126** may serve as an entry point for content provider MBMS transmission, may be used to authorize and initiate MBMS Bearer Services within a PLMN, and may be used to schedule and deliver MBMS transmissions. The MBMS Gateway **124** may be used to distribute MBMS traffic to the eNBs (e.g., **106**, **108**) belonging to a Multicast Broadcast Single Frequency Network (MBSFN) area broadcasting a particular service, and may be responsible for session management (start/stop) and for collecting eMBMS related charging information.

FIG. **2** is a diagram illustrating an example of an access network **200** in an LTE network architecture. In this example, the access network **200** is divided into a number of cellular regions (cells) **202**. One or more lower power class eNBs **208** may have cellular regions **210** that overlap with one or more of the cells **202**. The lower power class eNB **208** may be a femto cell (e.g., home eNB (HeNB)), pico cell, micro cell, or remote radio head (RRH). The macro eNBs **204** are each assigned to a respective cell **202** and are configured to provide an access point to the EPC **110** for all the UEs **206** in the cells **202**. There is no centralized controller in this example of an access network **200**, but a centralized controller may be used in alternative configurations. The eNBs **204** are responsible for all radio related functions including radio bearer control, admission control, mobility control, scheduling, security, and connectivity to the serving gateway **116**. An eNB may support one or multiple (e.g., three) cells (also referred to as a sector). The term "cell" can refer to the smallest coverage area of an eNB and/or an eNB subsystem serving are particular coverage area. Further, the terms "eNB," "base station," and "cell" may be used interchangeably herein.

The modulation and multiple access scheme employed by the access network **200** may vary depending on the particular telecommunications standard being deployed. In LTE applications, OFDM is used on the DL and SC-FDMA is used on the UL to support both frequency division duplex (FDD) and time division duplex (TDD). As those skilled in the art will readily appreciate from the detailed description to follow, the various concepts presented herein are well suited for LTE applications. However, these concepts may be readily extended to other telecommunication standards employing other modulation and multiple access techniques. By way of example, these concepts may be extended to Evolution-Data Optimized (EV-DO) or Ultra Mobile Broadband (UMB). EV-DO and UMB are air interface standards promulgated by the 3rd Generation Partnership Project 2 (3GPP2) as part of the CDMA2000 family of standards and employs CDMA to provide broadband Internet access to mobile stations. These concepts may also be extended to Universal Terrestrial Radio Access (UTRA) employing Wideband-CDMA (W-CDMA) and other variants of CDMA, such as TD-SCDMA; Global System for Mobile Communications (GSM) employing TDMA; and Evolved UTRA (E-UTRA), IEEE 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20, and Flash-OFDM employing OFDMA. UTRA, E-UTRA, UMTS, LTE and GSM are described in documents from the 3GPP organization. CDMA2000 and UMB are described in documents from the 3GPP2 organization. The actual wireless communication standard and the multiple access technology employed will depend on the specific application and the overall design constraints imposed on the system.

The eNBs **204** may have multiple antennas supporting MIMO technology. The use of MIMO technology enables the eNBs **204** to exploit the spatial domain to support spatial multiplexing, beamforming, and transmit diversity. Spatial multiplexing may be used to transmit different streams of data simultaneously on the same frequency. The data streams may be transmitted to a single UE **206** to increase the data rate or to multiple UEs **206** to increase the overall system capacity. This is achieved by spatially precoding each data stream (i.e., applying a scaling of an amplitude and a phase) and then transmitting each spatially precoded stream through multiple transmit antennas on the DL. The spatially precoded data streams arrive at the UE(s) **206** with different spatial signatures, which enables each of the UE(s) **206** to recover the one or more data streams destined for that UE **206**. On the UL, each UE **206** transmits a spatially precoded data stream, which enables the eNB **204** to identify the source of each spatially precoded data stream.

Spatial multiplexing is generally used when channel conditions are good. When channel conditions are less favorable, beamforming may be used to focus the transmission energy in one or more directions. This may be achieved by spatially precoding the data for transmission through multiple antennas. To achieve good coverage at the edges of the cell, a single stream beamforming transmission may be used in combination with transmit diversity.

In the detailed description that follows, various aspects of an access network will be described with reference to a MIMO system supporting OFDM on the DL. OFDM is a spread-spectrum technique that modulates data over a number of subcarriers within an OFDM symbol. The subcarriers are spaced apart at precise frequencies. The spacing provides "orthogonality" that enables a receiver to recover the data from the subcarriers. In the time domain, a guard interval (e.g., cyclic prefix) may be added to each OFDM symbol to combat inter-OFDM-symbol interference. The UL may use SC-FDMA in the form of a DFT-spread OFDM signal to compensate for high peak-to-average power ratio (PAPR).

FIG. **3** is a diagram **300** illustrating an example of a DL frame structure in LTE. A frame (10 ms) may be divided into 10 equally sized subframes. Each subframe may include two consecutive time slots. A resource grid may be used to represent two time slots, each time slot including a resource block. The resource grid is divided into multiple resource elements. In LTE, a resource block contains 12 consecutive subcarriers in the frequency domain and, for a normal cyclic prefix in each OFDM symbol, 7 consecutive OFDM symbols in the time domain, or **84** resource elements. For an extended cyclic prefix, a resource block contains 6 consecutive OFDM symbols in the time domain and has 72 resource elements. Some of the resource elements, indicated as R **302**, **304**, include DL reference signals (DL-RS). The DL-RS include Cell-specific RS (CRS) (also sometimes called common RS) **302** and UE-specific RS (UE-RS) **304**. UE-RS **304** are transmitted only on the resource blocks upon which the corresponding physical DL shared channel (PDSCH) is mapped. The number of bits carried by each resource element depends on the modulation scheme. Thus, the more resource blocks that a UE receives and the higher the modulation scheme, the higher the data rate for the UE.

FIG. **4** is a diagram **400** illustrating an example of an UL frame structure in LTE. The available resource blocks for the UL may be partitioned into a data section and a control section. The control section may be formed at the two edges of the system bandwidth and may have a configurable size. The resource blocks in the control section may be assigned to UEs for transmission of control information. The data section may include all resource blocks not included in the control section. The UL frame structure results in the data section including contiguous subcarriers, which may allow a single UE to be assigned all of the contiguous subcarriers in the data section.

A UE may be assigned resource blocks **410***a*, **410***b* in the control section to transmit control information to an eNB. The UE may also be assigned resource blocks **420***a*, **420***b* in the data section to transmit data to the eNB. The UE may transmit control information in a physical UL control channel (PUCCH) on the assigned resource blocks in the control section. The UE may transmit only data or both data and control information in a physical UL shared channel (PUSCH) on the assigned resource blocks in the data section. A UL transmission may span both slots of a subframe and may hop across frequency.

A set of resource blocks may be used to perform initial system access and achieve UL synchronization in a physical random access channel (PRACH) **430**. The PRACH **430** carries a random sequence and cannot carry any UL data/signaling. Each random access preamble occupies a bandwidth corresponding to six consecutive resource blocks. The starting frequency is specified by the network. That is, the transmission of the random access preamble is restricted to certain time and frequency resources. There is no frequency hopping for the PRACH. The PRACH attempt is carried in a single subframe (1 ms) or in a sequence of few contiguous subframes and a UE can make only a single PRACH attempt per frame (10 ms).

FIG. **5** is a diagram **500** illustrating an example of a radio protocol architecture for the user and control planes in LTE. The radio protocol architecture for the UE and the eNB is shown with three layers: Layer 1, Layer 2, and Layer 3. Layer 1 (L1 layer) is the lowest layer and implements various physical layer signal processing functions. The L1 layer will be referred to herein as the physical layer **506**. Layer 2 (L2 layer) **508** is above the physical layer **506** and is responsible for the link between the UE and eNB over the physical layer **506**.

In the user plane, the L2 layer **508** includes a media access control (MAC) sublayer **510**, a radio link control (RLC) sublayer **512**, and a packet data convergence protocol (PDCP) **514** sublayer, which are terminated at the eNB on the network side. Although not shown, the UE may have several upper layers above the L2 layer **508** including a network layer (e.g., IP layer) that is terminated at the PDN gateway **118** on the network side, and an application layer that is terminated at the other end of the connection (e.g., far end UE, server, etc.).

The PDCP sublayer **514** provides multiplexing between different radio bearers and logical channels. The PDCP sublayer **514** also provides header compression for upper layer data packets to reduce radio transmission overhead, security by ciphering the data packets, and handover support for UEs between eNBs. The RLC sublayer **512** provides segmentation and reassembly of upper layer data packets, retransmission of lost data packets, and reordering of data packets to compensate for out-of-order reception due to HARQ. The MAC sublayer **510** provides multiplexing between logical and transport channels. The MAC sublayer **510** is also responsible for allocating the various radio resources (e.g., resource blocks) in one cell among the UEs. The MAC sublayer **510** is also responsible for HARQ operations.

In the control plane, the radio protocol architecture for the UE and eNB is substantially the same for the physical layer **506** and the L2 layer **508** with the exception that there is no header compression function for the control plane. The control plane also includes a radio resource control (RRC) sublayer **516** in Layer 3 (L3 layer). The RRC sublayer **516** is responsible for obtaining radio resources (e.g., radio bearers) and for configuring the lower layers using RRC signaling between the eNB and the UE.

FIG. **6** is a block diagram of an eNB **610** in communication with a UE **650** in an access network. In the DL, upper layer packets from the core network are provided to a controller/processor **675**. The controller/processor **675** implements the functionality of the L2 layer. In the DL, the controller/processor **675** provides header compression, ciphering, packet segmentation and reordering, multiplexing between logical and transport channels, and radio resource allocations to the UE **650** based on various priority metrics. The controller/processor **675** is also responsible for HARQ operations, retransmission of lost packets, and signaling to the UE **650**.

The transmit (TX) processor **616** implements various signal processing functions for the L1 layer (i.e., physical layer). The signal processing functions include coding and interleaving to facilitate forward error correction (FEC) at the UE **650** and mapping to signal constellations based on various modulation schemes (e.g., binary phase-shift keying (BPSK), quadrature phase-shift keying (QPSK), M-phase-shift keying (M-PSK), M-quadrature amplitude modulation (M-QAM)). The coded and modulated symbols are then split into parallel streams. Each stream is then mapped to an OFDM subcarrier, multiplexed with a reference signal (e.g., pilot) in the time and/or frequency domain, and then combined together using an Inverse Fast Fourier Transform (IFFT) to produce a physical channel carrying a time domain OFDM symbol stream. The OFDM stream is spatially precoded to produce multiple spatial streams. Channel estimates from a channel estimator **674** may be used to determine the coding and modulation scheme, as well as for spatial processing. The channel estimate may be derived from a reference signal and/or channel condition feedback transmitted by the UE **650**. Each spatial stream may then be provided to a different antenna **620** via a separate transmitter **618**TX. Each transmitter **618**TX may modulate an RF carrier with a respective spatial stream for transmission.

At the UE **650**, each receiver **654**RX receives a signal through its respective antenna **652**. Each receiver **654**RX recovers information modulated onto an RF carrier and provides the information to the receive (RX) processor **656**. The RX processor **656** implements various signal processing functions of the L1 layer. The RX processor **656** may perform spatial processing on the information to recover any spatial streams destined for the UE **650**. If multiple spatial streams are destined for the UE **650**, they may be combined by the RX processor **656** into a single OFDM symbol stream. The RX processor **656** then converts the OFDM symbol stream from the time-domain to the frequency domain using a Fast Fourier Transform (FFT). The frequency domain signal comprises a separate OFDM symbol stream for each subcarrier of the OFDM signal. The symbols on each subcarrier, and the reference signal, are recovered and demodulated by determining the most likely signal constellation points transmitted by the eNB **610**. These soft

decisions may be based on channel estimates computed by the channel estimator **658**. The soft decisions are then decoded and deinterleaved to recover the data and control signals that were originally transmitted by the eNB **610** on the physical channel. The data and control signals are then provided to the controller/processor **659**.

The controller/processor **659** implements the L2 layer. The controller/processor can be associated with a memory **660** that stores program codes and data. The memory **660** may be referred to as a computer-readable medium. In the UL, the controller/processor **659** provides demultiplexing between transport and logical channels, packet reassembly, deciphering, header decompression, control signal processing to recover upper layer packets from the core network. The upper layer packets are then provided to a data sink **662**, which represents all the protocol layers above the L2 layer. Various control signals may also be provided to the data sink **662** for L3 processing. The controller/processor **659** is also responsible for error detection using an acknowledgement (ACK) and/or negative acknowledgement (NACK) protocol to support HARQ operations.

In the UL, a data source **667** is used to provide upper layer packets to the controller/processor **659**. The data source **667** represents all protocol layers above the L2 layer. Similar to the functionality described in connection with the DL transmission by the eNB **610**, the controller/processor **659** implements the L2 layer for the user plane and the control plane by providing header compression, ciphering, packet segmentation and reordering, and multiplexing between logical and transport channels based on radio resource allocations by the eNB **610**. The controller/processor **659** is also responsible for HARQ operations, retransmission of lost packets, and signaling to the eNB **610**.

Channel estimates derived by a channel estimator **658** from a reference signal or feedback transmitted by the eNB **610** may be used by the TX processor **668** to select the appropriate coding and modulation schemes, and to facilitate spatial processing. The spatial streams generated by the TX processor **668** may be provided to different antenna **652** via separate transmitters **654**TX. Each transmitter **654**TX may modulate an RF carrier with a respective spatial stream for transmission.

The UL transmission is processed at the eNB **610** in a manner similar to that described in connection with the receiver function at the UE **650**. Each receiver **618**RX receives a signal through its respective antenna **620**. Each receiver **618**RX recovers information modulated onto an RF carrier and provides the information to a RX processor **670**. The RX processor **670** may implement the L1 layer.

The controller/processor **675** implements the L2 layer. The controller/processor **675** can be associated with a memory **676** that stores program codes and data. The memory **676** may be referred to as a computer-readable medium. In the UL, the control/processor **675** provides demultiplexing between transport and logical channels, packet reassembly, deciphering, header decompression, control signal processing to recover upper layer packets from the UE **650**. Upper layer packets from the controller/processor **675** may be provided to the core network. The controller/processor **675** is also responsible for error detection using an ACK and/or NACK protocol to support HARQ operations.

Described herein are various aspects related to ensuring transmission of certain control data in TDD subframe reconfiguration. For example, aspects of control data reported by a UE to an eNB or other control data processes can be configured based on a TDD subframe reconfiguration to ensure transmission of the control data. In an example, TDD subframe reconfiguration can result in incompatible transmission configuration for the control data (e.g., a defined downlink frame in a new TDD subframe configuration where uplink control data was previously scheduled) and/or interference caused to/from other nearby eNBs or UEs over the same frequency using different TDD subframe configurations. For example, periodicity, content, priority, or other aspects of CSI, SRS, or similar information can be modified to facilitate communicating the CSI in TDD subframe reconfiguration. In addition, for example, HARQ retransmission feedback and related downlink HARQ soft buffer management can be modified to facilitate communicating such in TDD subframe reconfiguration. In other examples, different TDD subframe reconfigurations can be selected where a conflict is detected by the current TDD subframe configuration.

The LTE communications standard supports both frequency division duplexing (FDD) and TDD frame structures. The transmission timeline for the downlink and uplink may be partitioned into units of radio frames, and each radio frame may be partitioned into 10 subframes with indices of **0** through **9**. LTE supports a number of uplink-downlink configurations for TDD. Subframes **0** and **5** are used for the downlink and subframe **2** is used for the uplink for all uplink-downlink configurations. Subframes **3**, **4**, **7**, **8** and **9** may each be used for the downlink or uplink depending on the uplink-downlink configuration. Subframe **1** is a special subframe composed of a Downlink Pilot Time Slot (DwPTS), a Guard Period (GP), and an Uplink Pilot Time Slot (UpPTS). The DwPTS is used for downlink control channels as well as data transmission. The GP carries no transmissions. The UpPTS is used for either a random access channel (RACH) or SRSs transmissions. Subframe **6** may include only the DwPTS, or all three special fields, or a downlink subframe depending on the uplink-downlink configuration. The DwPTS, GP and UpPTS may have different durations for different subframe configurations. For TDD, subframes used for the downlink only may be referred to as a downlink subframe, and each subframe used for the uplink only may be referred to as an uplink subframe.

Changes to the implementation of the standards include the possibility of dynamically adapting TDD DL/UL subframe configurations based on the actual traffic needs. If, during a short duration, a large data burst on downlink is needed, a wireless apparatus may change its configuration from, for example, configuration #**1** (6 DL:4 UL) to configuration #**5** (9 DL:1 UL) (See Table 1, below). The adaptation of TDD configuration is expected to be no slower than 640 ms. In the extreme case, the adaptation may be as fast as 10 ms. Having adjacent cells dynamically switching between different subframe uplink-downlink configurations may cause interference to both downlink and uplink when two or more cells have different overlapping downlink and uplink subframes.

FIG. **7** illustrates a wireless communication system **700** experiencing eNB-to-eNB or UE-to-UE interference from varying TDD subframe configurations. System **700** includes eNBs **702** and **704** that respectively communicate with UEs **706** and **708**. The eNBs **702** and **704** can each be a macrocell, femtocell, picocell, or similar base station, a mobile base station, a relay, a UE (e.g., communicating in peer-to-peer or ad-hoc mode with UEs **706** and/or **708**), a portion thereof, and/or the like. UEs **706** and **708** can each be a mobile terminal, a stationary terminal, a modem (or other tethered device), a portion thereof, and/or the like.

The eNB **702** can assign a TDD subframe configuration to UE **706** for communicating therewith. In one example, a plurality of TDD subframe configurations and/or related information can be known at the eNB **702** and UE **706** such that the eNB **702** assigns certain TDD subframe configurations by communicating an identifier to UE **706**. Similarly, eNB **704** can assign a TDD subframe configuration for communicating with UE **708**. It is to be appreciated that eNBs **702** and **704** may not coordinate TDD subframe configuration assignment, and thus communications over the TDD subframes may cause interference among eNBs **702** and **704** and/or among UEs **706** and **708** where the communications are over the same frequency.

For example, where a TDD subframe configuration of eNB **704** schedules a downlink subframe and eNB **702** schedules the same subframe as uplink, the downlink transmission **710** from eNB **704** can interfere with the uplink transmission **711** from UE **706**. Similarly, an uplink transmission **712** from UE **706** can interfere with a downlink transmission **713** from eNB **704** at UE **708** (e.g., where UEs **706** and **708** are near to each other).

FIG. **8** is a diagram **800** illustrating TDD subframe configurations. For example, eNB **702** in FIG. **7** can assign TDD subframe configuration **814** for communicating with UE **706**. Subframes in subframe configuration **814** marked with 'D' corresponds to subframes reserved for downlink transmission from eNB **702** to UE **706**, 'U' corresponds to subframes reserved for uplink transmission from UE **706** to eNB **702**, 'S' corresponds to special subframes over which downlink or uplink communications are possible, etc. Similarly, eNB **704** can assign TDD subframe configuration **816** for communications with UE **708**. The configurations **814** and **816** are different in that at subframe **818**, configuration **814** schedules an uplink transmission while configuration **816** schedules a downlink transmission, which can result in the eNB-to-eNB interference or UE-to-UE interference as described above at subframe **818**.

Adaptive TDD subframe configurations can be provided by eNBs **702** and **704** for one or more UEs, such as UEs **706** and **708**, respectively, to accommodate different types of data, to handle loading at the eNB **702** or **704**, and/or the like. Thus, upon switching TDD subframe configurations at eNB **702** or eNB **704** for communications from UE **706** or **708**, respectively, various functions can be performed to mitigate such interference caused by allowing adaptive TDD subframe configurations and/or to handle subframe conflicts from one configuration to the next. For example, periodicity, content, priority, or other aspects of CSI, SRS, or similar information can be modified to facilitate communicating the CSI in a given TDD subframe configuration (e.g., based on a previous configuration). In another example, HARQ retransmission feedback and/or downlink HARQ soft buffer management can be modified to facilitate communicating HARQ in a given TDD subframe. In other examples, different TDD subframe configurations can be selected where a conflict or interference is caused by geographically close cells using different TDD subframe configurations.

FIGS. **9** through **14** illustrate example methodologies for modifying control transmissions or processes based on determining TDD subframe reconfigurations. While, for purposes of simplicity of explanation, the methodologies are shown and described as a series of acts, it is to be understood and appreciated that the methodologies are not limited by the order of acts, as some acts may, in accordance with one or more embodiments, occur in different orders and/or concurrently with other acts from that shown and described herein. For example, it is to be appreciated that a methodology could alternatively be represented as a series of interrelated states or events, such as in a state diagram. Moreover, not all illustrated acts may be required to implement a methodology in accordance with one or more embodiments.

FIG. **9** is a flowchart **900** of a method that facilitates modifying CSI or SRS transmission. The method may be performed by a UE, such as UE **706** or **708** that communicates with one or more eNBs, such as eNBs **702** or **704**. At step **902**, the UE detects a TDD subframe reconfiguration. For example, this can include receiving an indication from an eNB to switch the TDD subframe configuration. This can be based in part on receiving a new resource allocation from the eNB or otherwise. Allowing such adaptive TDD subframe configuration facilitates selecting TDD subframe configurations based on data demand or types of data being transmitted within a cell.

At step **904**, the UE modifies at least one aspect of a CSI or a SRS transmission based on the TDD subframe reconfiguration. For example, the UE may modify a periodicity, content, or priority for transmitting the CSI or SRS transmission. In one example, where a periodicity configured for CSI transmission conflicts with the new TDD subframe configuration, the CSI periodicity can be similarly reconfigured with the TDD subframe reconfiguration. In other examples, transmissions of the CSI that conflict with scheduled subframes of the TDD subframe reconfiguration can be dropped, a next highest or lowest CSI periodicity can be selected, and/or the like.

FIG. **10** is a flowchart **1000** of a method that facilitates modifying a CSI transmission. The method may be performed by a UE, such as UE **706** or **708** that communicates with one or more eNBs, such as eNBs **702** or **704**. At step **1002**, the UE receives a TDD subframe reconfiguration from an eNB. At step **1004**, the UE detects a conflict with a scheduled CSI transmission.

It should be understood that the path including steps **1008**, **1016**, and **1018**, the path including steps **1010**, **1016**, and **1018**, the path including steps **1012**, **1016**, and **1018**, and the path including steps **1014**, **1016**, and **1018** represent alternative mechanisms for resolving a CSI transmission conflict. It should be further understood that any or all of the previously described paths may exclude steps **1016** and **1018**. Therefore, a UE implementing the method of flowchart **1000** may perform any of the steps in the previously described paths, with or without steps **1016** and **1018**. It should be noted that any of the steps **1008**, **1010**, **1012**, and **1014** may be performed sequentially, in parallel, in various orders, and in various combinations with or without steps **1016** and **1018**.

At step **1006**, the UE receives a configuration index related to a new periodicity for the CSI transmission. At step **1008**, the UE modifies the periodicity of the CSI transmission to resolve the detected conflict. In an aspect, the UE modifies the periodicity of the CSI transmission based on the received configuration index related to the new periodicity. In another aspect, the UE modifies the periodicity of the CSI transmission by dropping at least one instance of the CSI transmission. In another aspect, the UE modifies the periodicity of the CSI transmission by utilizing a configuration corresponding to a next lowest or highest configuration index related to the CSI transmission.

At step **1010**, the UE modifies a content of the CSI transmission to resolve the detected conflict. In an aspect, the UE modifies the content of the CSI transmission by computing a subband for transmitting the CSI transmission based on at least one of a TDD subframe configuration

before the TDD subframe reconfiguration or a TDD subframe configuration after the TDD subframe reconfiguration.

At step **1012**, the UE modifies a rank indicator or a precoding type indicator related to the CSI transmission to resolve the detected conflict. In an aspect, the UE modifies the rank indicator or the precoding type indicator by using at least one of a previous rank indicator or a precoding type indicator from a TDD subframe configuration before the TDD subframe reconfiguration, a previous rank indicator or a precoding type indicator from a TDD subframe configuration after the TDD subframe reconfiguration, a common rank indicator or a precoding type indicator for the TDD subframe reconfiguration, or a lowest allowed rank indicator or a precoding type indicator. At step **1014**, the UE selects a next TDD subframe reconfiguration in a set of received TDD subframe reconfigurations to resolve the detected conflict.

At step **1016**, the UE detects a different TDD subframe reconfiguration for a data transmission. At step **1018**, the UE modifies the data transmission based on the different TDD subframe configuration.

FIG. **11** is a flowchart **1100** of a method that facilitates modifying an SRS transmission. The method may be performed by a UE, such as UE **706** or **708** that communicates with one or more eNBs, such as eNBs **702** or **704**. At step **1102**, the UE receives a TDD subframe reconfiguration from an eNB. At step **1104**, the UE detects a conflict with a scheduled SRS transmission. At step **1106**, the UE receives a configuration index related to a new periodicity for the SRS transmission.

It should be understood that the path including steps **1108**, **1116**, and **1118**, the path including steps **1110**, **1116**, and **1118**, the path including steps **1112**, **1116**, and **1118**, and the path including steps **1114**, **1116**, and **1118** represent alternative mechanisms for resolving an SRS transmission conflict. It should be further understood that any or all of the previously described paths may exclude steps **1116** and **1118**. Therefore, a UE implementing the method of flowchart **1100** may perform any of the steps in the previously described paths, with or without steps **1116** and **1118**. It should be noted that any of the steps **1108**, **1110**, **1112**, and **1114** may be performed sequentially, in parallel, in various orders, and in various combinations with or without steps **1116** and **1118**.

At step **1108**, the UE modifies the periodicity of the SRS transmission to resolve the detected conflict. In an aspect, the UE modifies the periodicity of the SRS transmission based on the received configuration index related to the new periodicity. In another aspect, the UE modifies the periodicity of the SRS transmission by dropping at least one instance of the SRS transmission. In another aspect, the UE modifies the periodicity of the SRS transmission by utilizing a configuration corresponding to a next lowest or highest configuration index related to the SRS transmission.

At step **1110**, the UE modifies a content of the SRS transmission to resolve the detected conflict. In an aspect, the UE modifies the content of the SRS transmission by computing a subband for transmitting the SRS transmission based on at least one of a TDD subframe configuration before the TDD subframe reconfiguration or a TDD subframe configuration after the TDD subframe reconfiguration.

At step **1112**, the UE modifies a rank indicator or a precoding type indicator related to the SRS transmission to resolve the detected conflict. In an aspect, the UE modifies the rank indicator or the precoding type indicator by using at least one of a previous rank indicator or a precoding type indicator from a TDD subframe configuration before the TDD subframe reconfiguration, a previous rank indicator or a precoding type indicator from a TDD subframe configuration after the TDD subframe reconfiguration, a common rank indicator or a precoding type indicator for the TDD subframe reconfiguration, or a lowest allowed rank indicator or a precoding type indicator. At step **1114**, the UE selects a next TDD subframe reconfiguration in a set of received TDD subframe reconfigurations to resolve the detected conflict.

At step **1116**, the UE detects a different TDD subframe reconfiguration for a data transmission. At step **1118**, the UE modifies the data transmission based on the different TDD subframe configuration.

FIG. **12** is a flowchart **1200** of a method for modifying a HARQ process. The method may be performed by a UE, such as UE **706** or **708** that communicates with one or more eNBs, such as eNBs **702** or **704**. At step **1202**, the UE detects a TDD subframe reconfiguration. For example, this can include receiving by the UE an indication from an eNB to switch the TDD subframe configuration. This can be based in part on receiving a new resource allocation from the eNB or otherwise. Allowing such adaptive TDD subframe configuration facilitates selecting TDD subframe configurations based on data demand or types of data being transmitted at an eNB, etc.

At step **1204**, the UE modifies at least a HARQ soft buffer size or a codebook size for a HARQ process based on the TDD subframe reconfiguration. For example, the UE may modify the HARQ soft buffer size by determining the HARQ soft buffer size for the HARQ process based on at least one of a TDD subframe configuration before the TDD subframe reconfiguration or a TDD subframe configuration after the TDD subframe reconfiguration, and applying the determined HARQ soft buffer size. As another example, the UE may modify the HARQ soft buffer size by determining the HARQ soft buffer size for the HARQ process based on a static or semi-static value during transition to the TDD subframe reconfiguration, or based on a dynamic value outside of the TDD subframe reconfiguration, and applying the determined HARQ soft buffer size. For example, the UE may modify the codebook size for a HARQ process by determining the codebook size for the HARQ process in carrier aggregation, and applying the determined codebook size.

FIG. **13** is a flowchart **1300** of a method for modifying a HARQ process. The method may be performed by a UE, such as UE **706** or **708** that communicates with one or more eNBs, such as eNBs **702** or **704**. At step **1302**, the UE receives a downlink transmission from an eNB. At step **1304**, the UE receives a TDD subframe reconfiguration from the eNB. At step **1306**, the UE detects a HARQ conflict based on the reconfiguration. At step **1308**, the UE determines a HARQ soft buffer size for a HARQ process. In an aspect, the UE determines the HARQ soft buffer size based on at least one of a TDD subframe configuration before the TDD subframe reconfiguration or a TDD subframe configuration after the TDD subframe reconfiguration. In another aspect, the UE determines the HARQ soft buffer size based on a static or semi-static value during transition to the TDD subframe reconfiguration, or based on a dynamic value outside of the TDD subframe reconfiguration. At step **1310**, the UE applies the determined HARQ soft buffer size to resolve the detected conflict.

At step **1312**, the UE determines a codebook size for a HARQ process in carrier aggregation. At step **1314**, the UE applies the determined codebook size to resolve the detected

conflict. At step **1316**, the UE detects a different TDD subframe reconfiguration for a data transmission. At step **1318**, the UE modifies the data transmission based on the different TDD subframe configuration.

It should be understood that the path including steps **1308**, **1310**, **1316** and **1318** and the path including steps **1312**, **1314**, **1316**, and **1318** represent alternative mechanisms for resolving a HARQ transmission conflict. It should be further understood that either or both of the previously described paths may exclude steps **1316** and **1318**. Therefore, a UE implementing the method of flowchart **1300** may perform any of the steps in the previously described paths, with or without steps **1316** and **1318**. It should be noted that any of the steps **1308**, **1310**, **1312**, and **1314** may be performed sequentially, in parallel, in various orders, and in various combinations with or without steps **1316** and **1318**.

FIG. **14** is a diagram **1400** illustrating an example apparatus **1402** for mitigating conflicts in TDD subframe reconfiguration. Apparatus **1402** can be a UE, such as UE **706** or **708**, that communicates with one or more eNBs, such as eNBs **702** or **704**, in a wireless network to receive access thereto, and can include additional modules than those depicted to facilitate such communicating. Apparatus **1402** can include a TDD reconfiguration detecting module **1401** for determining subframe reconfiguration of TDD based on resource allocation information from an eNB, a control transmission modifying module **1404** for modifying one or more aspects of communicating control data based on the TDD subframe reconfiguration, and a control transmitting module for communicating the control data based on the modified aspects. In addition, apparatus **1402** can optionally include a HARQ processing module **1414** for modifying one or more aspects of HARQ reception based on TDD subframe reconfiguration, and/or a TDD reconfiguring module **1416** for selecting a different TDD subframe configuration where conflicts or interference are detected.

According to an example, apparatus **1402** can communicate in a wireless network using a TDD subframe configuration assigned by an eNB. The eNB can reconfigure the TDD subframe configuration for apparatus **1402**, which can be detected by TDD reconfiguration detecting module **1401**. For example, TDD reconfiguration detecting module **1401** can detect the TDD subframe reconfiguration based on an allocation from the eNB that specifies a TDD subframe configuration to use in communicating with the eNB (e.g., which can be different from a previous TDD subframe configuration), based on an updated TDD subframe configuration received from the eNB in another indication or signal, and/or the like. Control transmission modifying module **1404** can modify one or more aspects for transmission of control data based on the TDD subframe reconfiguration, and control transmitting module **1406** can transmit control data to the eNB based on the one or more modified aspects.

In an example, with reference to Table 1, possible TDD subframe configurations can be one of the following:

TABLE 1

| UL-DL config- | DL-to-UL Switch-point | Subframe number | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| uration | periodicity | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 0 | 5 ms | D | S | U | U | U | D | S | U | U | U |
| 1 | 5 ms | D | S | U | U | D | D | S | U | U | D |
| 2 | 5 ms | D | S | U | D | D | D | S | U | D | D |
| 3 | 10 ms | D | S | U | U | U | D | D | D | D | D |
| 4 | 10 ms | D | S | U | U | D | D | D | D | D | D |
| 5 | 10 ms | D | S | U | D | D | D | D | D | D | D |
| 6 | 5 ms | D | S | U | U | U | D | S | U | U | D |

where 'D' indicates downlink transmission, 'U' indicates uplink transmission, and 'S' indicates special subframe, which can be used for uplink or downlink transmission. The apparatus **1402** can store such information regarding the TDD subframe configurations; thus, an eNB can communicate a configuration index (e.g., **0-6**) to apparatus **1402** for the intended TDD subframe configuration. The apparatus **1402** can communicate according to the TDD subframe configuration, and in this example, TDD reconfiguration detecting module **1401** can detect the TDD subframe reconfiguration based on receiving a different index from the eNB (e.g., in a resource allocation or otherwise). It is to be appreciated that additional TDD subframe configurations can be defined and used.

In one example, control transmission modifying module **1404** can optionally include a CSI transmitting module **1408** for modifying one or more aspects of CSI transmission based on TDD subframe reconfiguration, an SRS transmitting module **1410** for similarly modifying one or more aspects of SRS transmission, and/or a HARQ transmitting module **1412** for modifying one or more aspects of HARQ transmission.

For example, CSI transmitting module **1408** can modify a periodicity of CSI transmission based on a determined TDD subframe reconfiguration. In a specific example, CSI transmission can include communicating channel quality indicator (CQI), precoding matrix indicator (PMI), rank indicator (RI), and/or similar feedback. With reference to Table 2, CSI transmitting module **1408** can transmit the CSI according to one of the following periodicities specified by the eNB or otherwise configured at apparatus **1402**:

TABLE 2

| $I_{CQI/PMI}$ | Value of $N_{pd}$ | Value of $N_{OFFSET,\ CQI}$ |
|---|---|---|
| $I_{CQI/PMI} = 0$ | 1 | $I_{CQI/PMI}$ |
| $1 \le I_{CQI/PMI} \le 5$ | 5 | $I_{CQI/PMI} - 1$ |
| $6 \le I_{CQI/PMI} \le 15$ | 10 | $I_{CQI/PMI} - 6$ |
| $16 \le I_{CQI/PMI} \le 35$ | 20 | $I_{CQI/PMI} - 16$ |
| $36 \le I_{CQI/PMI} \le 75$ | 40 | $I_{CQI/PMI} - 36$ |
| $76 \le I_{CQI/PMI} \le 155$ | 80 | $I_{CQI/PMI} - 76$ |
| $156 \le I_{CQI/PMI} \le 315$ | 160 | $I_{CQI/PMI} - 156$ |
| $316 \le I_{CQI/PMI} \le 1023$ | | Reserved |

where $I_{CQI/PMI}$ is a parameter cqi-pmi-ConfigIndex representing the configuration index of a CSI transmission periodicity received from the eNB, $N_{pd}$ is the periodicity (in subframes) corresponding to the index, and $N_{OFFSET,CQI}$ is the offset (in subframes) for CSI reporting. Thus, based on a received or otherwise determined index, CSI transmitting module **1408** can transmit CSI to the eNB according to the periodicity $N_{pd}$, based on offset $N_{OFFSET,CQI}$ Some of the above periodicities, however, may not be compatible with certain TDD subframe configurations. In this regard, upon TDD reconfiguration detecting module **1401** determining a TDD subframe reconfiguration, CSI transmitting module **1408** may modify the CSI periodicity to one compatible with the new TDD subframe configuration.

For instance, the reporting period of $N_{pd}$=1 is only applicable to TDD subframe configurations **0**, **1**, **3**, **4**, and **6**, above, where all uplink (U) subframes in a radio frame are used for CQI/PMI reporting, but not to subframe configurations **2** or **5** because there may not be enough time to transmit the control data in a single uplink subframe. In addition, the reporting period of $N_{pd}$=5 is only applicable to TDD subframe configurations **0**, **1**, **2**, and **6**, but not subframe configurations **3**, **4**, or **5** because there may not be enough opportunities to transmit uplink control data every 5 subframes. The reporting periods of $N_{pd}$={10, 20, 40, 80, 160} are applicable to all TDD subframe configurations. For example, a CSI reporting conflict may occur where apparatus **1402** is assigned reporting period of $N_{pd}$=5 but TDD reconfiguration detecting module **1401** detects a switch to TDD subframe configuration **3** (which does not support an $N_{pd}$=5).

To cure such conflicts, in one example, the TDD reconfiguration detecting module **1401** can detect the conflict or otherwise receive a new CSI periodicity along with (or related to) the new TDD subframe configuration, as specified by the eNB. For example, detecting the conflict can include evaluating the TDD subframe configuration and aspects of the CSI. In another example, CSI transmitting module **1408** can drop CSI transmission during conflicting subframes, e.g., subframes previously correlated to a CSI transmission that are now scheduled for downlink transmission in the new TDD subframe configuration. In yet another example, CSI transmitting module **1408** can detect the conflict between CSI periodicity and a new TDD subframe configuration, and can accordingly use a next highest CSI periodicity. For example, where CSI transmitting module **1408** was using $N_{pd}$=5, the CSI transmitting module **1408** can switch to $N_{pd}$=10 based on detecting the conflict. Similarly, the CSI transmitting module **1408** can switch to the next lowest CSI periodicity.

In addition, CSI transmitting module **1408** can modify CSI content upon determining the TDD subframe reconfiguration. CSI content can include wideband CSI reporting, subband CSI reporting with or without precoding type indicator (PTI), etc. For example, CSI transmitting module **1408** can use the following rules for reporting CSI. In the case where wideband CSI reporting is configured, the reporting instances for wideband CSI are subframes satisfying:

$$(10\times n_f+\lfloor n_s/2\rfloor-N_{OFFSET,CQI})\bmod(N_{pd})=0$$

where $n_f$ is a system frame number, and $n_s$ is a slot index within a radio frame. In case RI reporting is configured, the reporting interval of the RI reporting is an integer multiple $M_{RI}$ of period $N_{pd}$, in subframes. The reporting instances for RI can be subframes satisfying:

$$(10\times n_f+\lfloor n_s/2\rfloor+N_{OFFSET,CQI}-N_{OFFSET,RI})\bmod (N_{pd}\cdot M_{RI})=0$$

Thus, the CSI transmitting module **1408** uses a hopping pattern to transmit CSI. Where TDD subframe reconfiguration is detected, CSI transmitting module **1408** can determine which reporting instances to use in view of the reconfiguration, whether the instances for the previous TDD subframe configuration as computed using the formula above, or the instances computed for the new TDD subframe configuration, etc. In one example, following TDD reconfiguration, CSI transmitting module **1408** can transmit CSI at a next instance computed for the previous TDD subframe configuration. In another example, following TDD reconfiguration determined by TDD reconfiguration detecting module **1401**, CSI transmitting module **1408** can compute reporting instances for the new TDD subframe configuration and can transmit CSI using an instance that corresponds to the current subframe index. In yet another example, CSI transmitting module **1408** can reset the subframe configuration and instances for reporting CSI upon TDD reconfiguration detecting module **1401** determining the TDD subframe reconfiguration; thus, in this example, CSI transmitting module **1408** uses the initial reporting instance for the next CSI reporting following TDD subframe reconfiguration.

Moreover, in an example, CSI transmitting module **1408** can modify a priority of transmitting CSI based on detecting the TDD subframe reconfiguration. Some CSI values, such as RI and PTI, impact transmission of other CSI and control data and can be necessary for decoding such control data. Thus, the CSI transmitting module **1408** can determine the correct values for RI and PTI when the TDD subframe configuration is modified. In this regard, CSI transmitting module **1408** can use a previous RI and PTI, from before the detected TDD subframe reconfiguration, for the new TDD subframe configuration. In another example, CSI transmitting module **1408** can specify a new RI or PTI based on determining the TDD subframe reconfiguration. In yet another example, RI and PTI reporting can use a common subframe or common periodicity such that CSI transmitting module **1408** can use a previous RI or PTI following the TDD subframe reconfiguration until the opportunity to report a new RI and PTI for the TDD subframe reconfiguration. In a further example, CSI transmitting module **1408** can transmit RI and PTI using a lowest allowed rank, which may be subject to a precoding subset restriction (e.g., can only use rank **2**-**4**). It is to be appreciated that CSI transmitting module **1408** can use a combination of one or more of the above examples in transmitting CSI based on a determined TDD subframe reconfiguration. It is to be appreciated that in the above and below examples, an eNB receiving the control data can similarly expect the related changes to control data transmissions.

Similarly, SRS transmitting module **1410** can modify SRS transmission periodicity based on a detected TDD subframe reconfiguration to avoid conflict caused by uplink SRS transmission periods in scheduled downlink subframes. In a specific example, with reference to Table 3, SRS transmission periodicity at apparatus **1402** can be one of the following:

TABLE 3

| SRS Configuration Index $I_{SRS}$ | SRS Periodicity $T_{SRS}$ (ms) | SRS Subframe Offset $T_{offset}$ |
|---|---|---|
| 0 | 2 | 0, 1 |
| 1 | 2 | 0, 2 |
| 2 | 2 | 1, 2 |
| 3 | 2 | 0, 3 |
| 4 | 2 | 1, 3 |
| 5 | 2 | 0, 4 |
| 6 | 2 | 1, 4 |
| 7 | 2 | 2, 3 |
| 8 | 2 | 2, 4 |
| 9 | 2 | 3, 4 |
| 10-14 | 5 | $I_{SRS}$ - 10 |
| 15-24 | 10 | $I_{SRS}$ - 15 |
| 25-44 | 20 | $I_{SRS}$ - 25 |
| 45-84 | 40 | $I_{SRS}$ - 45 |
| 85-164 | 80 | $I_{SRS}$ - 85 |
| 165-324 | 160 | $I_{SRS}$ - 165 |
| 325-644 | 320 | $I_{SRS}$ - 325 |
| 645-1023 | reserved | reserved |

Thus, an eNB can specify one of the above configuration indices for the apparatus **1402**, and/or the apparatus **1402** can otherwise determine the SRS configuration index. SRS transmitting module **1410** can modify aspects of SRS transmission where TDD subframe reconfiguration may cause conflict therewith. This can be similar to the CSI modifications discussed above. Thus, for example, SRS transmitting module **1410** can at least one of receive an SRS configuration index corresponding to the new TDD subframe configuration from the eNB (e.g. in uplink pilot time slot (UpPTS)), drop SRS when transmission is not compatible with the new TDD subframe configuration in terms of subframe type, transmit SRS over a next available uplink subframe to avoid a conflict, automatically switch to a next highest or lowest configuration index, etc.

Similarly, SRS transmitting module **1410** can modify hopping over instances based on determining the TDD subframe reconfiguration. For example, SRS transmitting module **1410** can continue to use a hopping pattern for the previous TDD subframe configuration, use a new hopping pattern for the new TDD subframe configuration, reset the transmission instances based on detecting the TDD subframe reconfiguration, and/or the like.

In another example, HARQ processing module **1414** can modify a soft buffer for HARQ retransmissions received from an eNB. For each subframe where a transmission takes place for the HARQ process, one or two (in case of downlink spatial multiplexing) transport blocks and the associated HARQ information are received from the HARQ entity. Depending on the new transmission or old transmission, HARQ processing module **1414** stores or combines with old log likelihood ratios in the buffer. Depending on the decoding results, HARQ processing module **1414** sends acknowledgement (ACK) or non-ACK (HACK). Furthermore, both for FDD and TDD, if a UE is configured with more than one serving cell, then for each serving cell, for at least $K_{MIMO} \cdot \min(M_{DL_HARQ}, M_{limit})$ transport blocks, upon decoding failure of a code block of a transport block, the UE can store received soft channel bits corresponding to a range of at least $w_k$ $w_{k+1}, \ldots, w_{mod(k+n_{SB}-1,N_{cb})}$, where:

$$n_{SB} = \min\left(N_{cb}, \left\lfloor \frac{N'_{soft}}{C \cdot N_{cells}^{DL} \cdot K_{MIMO} \cdot \min(M_{DL_HARQ}, M_{limit})} \right\rfloor\right),$$

where $N_{cb}$ is the soft buffer size, $N_{cb}$ is the code block buffer size as defined in the LTE standard, $N'_{soft}$ is the total number of soft channel bits (e.g., based on a UE category), C is a the number of code blocks, $N_{cells}^{DL}$ is the number of downlink cells, $K_{MIMO}$ relates to whether MIMO is active (e.g., a number of MIMO resources), $M_{DL_HARQ}$ is the maximum number of downlink HARQ processes, $M_{limit}$ is a constant.

Different TDD subframe configurations can have different downlink HARQ processes; thus, HARQ processing module **1414** can attempt to avoid ambiguity in the soft buffer size caused by determining the soft buffer size for HARQ processing when transitioning between TDD subframe configurations. In one example, if there is unfinished HARQ transmission, HARQ processing module **1414** can use the previous HARQ process until the transmission is finished (e.g., uses $M_{DL_HARQ}$ of the previous TDD subframe configuration for determining the soft buffer size, which can minimize loss of the previous HARQ). In another example, HARQ processing module **1414** can use a soft buffer size related to the new TDD subframe configuration (e.g., computed using $M_{DL_HARQ}$ of the new TDD subframe configuration) immediately upon transitioning from the TDD subframe configuration. Thus, for example, HARQ processing module **1414** can use a configuration dependent $M_{DL_HARQ}$ to determine the soft buffer size. In another example, a static or semi-static soft buffer size can be used during the transition (e.g., computed based on $M_{limit}$, or allow radio resource control (RRC) configured fixed number instead of $\min\{M_{limit}, M_{DL_HARQ}\}$) to simplify the HARQ process. Moreover, in an example, HARQ processing module **1414** can use the static or semi-static soft buffer size during TDD subframe configuration transitions while using a dynamic size outside of transition. For instance, the HARQ processing module **1414** can select or compute the dynamic size based on an RRC defined set of parameters.

In yet another example, apparatus **1402** can communicate with the eNB (and/or other eNBs) over multiple carriers in carrier aggregation. In a specific example in LTE, physical uplink control channel (PUCCH) format 3 or PUCCH format 1b with channel selection can be configured for apparatus **1402**. For format 3, HARQ transmitting module **1412** concatenates ACK information bits from different cells. Where scheduling request is on the same subframe, it is further concatenated to the end. In addition, the HARQ transmitting module **1412** determines ACK/NACK bit width semi-statically based on the configured DL modes for each component carrier (CC) in CA, and the number of semi-statically configured CCs, and CC activation/deactivation does not impact the ACK/NACK bit width (referred to as codebook size). Thus, in the case of adaptive TDD subframe reconfiguration over multiple carriers, the HARQ transmitting module **1412** can determine the codebook size by assuming a larger of the configurations of the two TDD subframe configurations. In another example, HARQ transmitting module **1412** can determine the codebook size by using the different sizes during transition, as determined by the downlink modes and CCs before and after the transition. In yet another example, HARQ transmitting module **1412** can refrain from changing feedback mode during the transition. For instance, if TDD reconfiguration detecting component receives a switch to a subframe configuration that is incompatible with PUCCH format of the previous TDD subframe configuration, it can ignore TDD configuration.

TDD reconfiguring module **1416** can reconfigure apparatus **1402**, which can include configuring a transceiver thereof, to use a new TDD subframe configuration received from the eNB. In another example, TDD reconfiguration detecting module **1401** can obtain a set of reconfiguration possibilities. Where TDD reconfiguration detecting module **1401** determines that an assigned TDD subframe reconfiguration may cause conflict with current CSI transmissions, TDD reconfiguration detecting module **1401** can evaluate a next configuration in a received set of TDD subframe configurations until a desirable configuration is obtained. For example, TDD reconfiguration detecting module **1401** can determine such conflicts based on evaluating the new TDD subframe configuration against periodicities configured for transmitting control data, other control processes, etc., as described. In another example, TDD reconfiguration detecting module **1401** can receive separate TDD subframe configurations for CSI transmission and data transmissions. In either case, TDD reconfiguring module **1416** can configure apparatus **1402** or related transceiver or other component to use the received or determined TDD subframe configuration.

The apparatus may include additional modules that perform each of the steps of the algorithm in the aforementioned flow charts of FIGS. **8** and **9**. As such, each step in the

aforementioned flow charts of FIGS. **8** and **9** may be performed by a module and the apparatus may include one or more of those modules. The modules may be one or more hardware components specifically configured to carry out the stated processes/algorithm, implemented by a processor configured to perform the stated processes/algorithm, stored within a computer-readable medium for implementation by a processor, or some combination thereof.

FIG. **15** is a diagram **1500** illustrating an example of a hardware implementation for an apparatus **1402'** employing a processing system **1514**. The processing system **1514** may be implemented with a bus architecture, represented generally by the bus **1524**. The bus **1524** may include any number of interconnecting buses and bridges depending on the specific application of the processing system **1514** and the overall design constraints. The bus **1524** links together various circuits including one or more processors and/or hardware modules, represented by the processor **1504**, the modules **1401**, **1404**, **1406**, **1414**, **1416**, and the computer-readable medium **1506**. The bus **1524** may also link various other circuits such as timing sources, peripherals, voltage regulators, and power management circuits, which are well known in the art, and therefore, will not be described any further.

The processing system **1514** may be coupled to a transceiver **1510**. The transceiver **1510** is coupled to one or more antennas **1520**. The transceiver **1510** provides a means for communicating with various other apparatus over a transmission medium. The transceiver **1510** receives a signal from the one or more antennas **1520**, extracts information from the received signal, and provides the extracted information to the processing system **1514**. In addition, the transceiver **1510** receives information from the processing system **1514**, and based on the received information, generates a signal to be applied to the one or more antennas **1520**. The processing system **1514** includes a processor **1504** coupled to a computer-readable medium **1506**. The processor **1504** is responsible for general processing, including the execution of software stored on the computer-readable medium **1506**. The software, when executed by the processor **1504**, causes the processing system **1514** to perform the various functions described supra for any particular apparatus. The computer-readable medium **1506** may also be used for storing data that is manipulated by the processor **1504** when executing software. The processing system further includes at least one of the modules **1401**, **1404**, **1406**, **1414**, **1416**. The modules may be software modules running in the processor **1504**, resident/stored in the computer readable medium **1506**, one or more hardware modules coupled to the processor **1504**, or some combination thereof. The processing system **1514** may be a component of the UE **650** and may include the memory **660** and/or at least one of the TX processor **668**, the RX processor **656**, and the controller/processor **659**.

In one configuration, the apparatus **1402/1402'** for wireless communication includes means for detecting a TDD subframe reconfiguration, means for modifying at least one aspect of a CSI or an SRS transmission based on the TDD subframe reconfiguration, means for detecting a different TDD subframe reconfiguration for a data transmission, means for modifying the data transmission based on the different TDD subframe reconfiguration, and means for modifying at least a HARQ soft buffer size or a codebook size for a HARQ process based on the TDD subframe reconfiguration.

The aforementioned means may be one or more of the aforementioned modules of the apparatus **1402** and/or the processing system **1514** of the apparatus **1402'** configured to perform the functions recited by the aforementioned means. As described supra, the processing system **1514** may include the TX Processor **668**, the RX Processor **656**, and the controller/processor **659**. As such, in one configuration, the aforementioned means may be the TX Processor **668**, the RX Processor **656**, and the controller/processor **659** configured to perform the functions recited by the aforementioned means.

It is understood that the specific order or hierarchy of steps in the processes disclosed is an illustration of exemplary approaches. Based upon design preferences, it is understood that the specific order or hierarchy of steps in the processes may be rearranged. Further, some steps may be combined or omitted. The accompanying method claims present elements of the various steps in a sample order, and are not meant to be limited to the specific order or hierarchy presented.

The previous description is provided to enable any person skilled in the art to practice the various aspects described herein. Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects. Thus, the claims are not intended to be limited to the aspects shown herein, but is to be accorded the full scope consistent with the language claims, wherein reference to an element in the singular is not intended to mean "one and only one" unless specifically so stated, but rather "one or more." Unless specifically stated otherwise, the term "some" refers to one or more. Combinations such as "at least one of A, B, or C," "at least one of A, B, and C," and "A, B, C, or any combination thereof" include any combination of A, B, and/or C, and may include multiples of A, multiples of B, or multiples of C. Specifically, combinations such as "at least one of A, B, or C," "at least one of A, B, and C," and "A, B, C, or any combination thereof" may be A only, B only, C only, A and B, A and C, B and C, or A and B and C, where any such combinations may contain one or more member or members of A, B, or C. All structural and functional equivalents to the elements of the various aspects described throughout this disclosure that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the claims. Moreover, nothing disclosed herein is intended to be dedicated to the public regardless of whether such disclosure is explicitly recited in the claims. No claim element is to be construed as a means plus function unless the element is expressly recited using the phrase "means for."

What is claimed is:

**1**. A method performed by a user equipment (UE) for configuring control data communications based on a time division duplexing (TDD) subframe reconfiguration, comprising:

detecting a TDD subframe reconfiguration from a first TDD subframe configuration to a second TDD subframe configuration;

detecting a scheduling conflict with a scheduled channel state information (CSI) transmission or a sounding reference signal (SRS) transmission based on the TDD subframe reconfiguration; and

modifying at least one aspect of the CSI transmission or the SRS transmission based on the TDD subframe reconfiguration, comprising

modifying a periodicity of the CSI or the SRS transmission of the second TDD subframe configuration, wherein the modifying the periodicity comprises

dropping at least one instance of the CSI or SRS transmission based on the detected scheduling conflict with the TDD subframe reconfiguration.

2. The method of claim 1, wherein the modifying the periodicity further comprises utilizing a configuration corresponding to a next lowest or highest configuration index related to the CSI or the SRS transmission.

3. The method of claim 1, wherein the modifying comprises modifying a content of the CSI or the SRS transmission.

4. The method of claim 3, wherein the modifying the content comprises computing a subband for transmitting the CSI or the SRS transmission based on at least one of a TDD subframe configuration before the TDD subframe reconfiguration or a TDD subframe configuration after the TDD subframe reconfiguration.

5. The method of claim 1, wherein the modifying comprises modifying a rank indicator (RI) or a precoding type indicator (PTI) related to the CSI or the SRS transmission.

6. The method of claim 5, wherein the modifying the RI or the PTI comprises using at least one of a previous RI or PTI from a TDD subframe configuration before the TDD subframe reconfiguration, a previous RI or PTI from a TDD subframe configuration after the TDD subframe reconfiguration, a common RI or PTI for the TDD subframe reconfiguration, or a lowest allowed RI or PTI.

7. The method of claim 1, wherein the modifying comprises selecting the next TDD subframe reconfiguration in a set of received TDD subframe reconfigurations based on detecting the conflict between the CSI or the SRS transmission and the TDD subframe reconfiguration.

8. The method of claim 1, wherein the modifying the comprises:

detecting the different TDD subframe reconfiguration for the data transmission; and

modifying the data transmission based on the different TDD subframe reconfiguration.

9. A user equipment for configuring control data communications based on a time division duplexing (TDD) subframe reconfiguration, comprising:

means for detecting a TDD subframe reconfiguration from a first TDD subframe configuration to a second TDD subframe configuration;

means for detecting a scheduling conflict with a scheduled channel state information (CSI) transmission or a sounding reference signal (SRS) transmission based on the TDD subframe reconfiguration; and

means for modifying at least one aspect of the CSI transmission or the SRS transmission based on the TDD subframe reconfiguration, including

modifying a periodicity of the CSI or the SRS transmission of the second TDD subframe configuration, wherein the modifying the periodicity comprises dropping at least one instance of the CSI or SRS transmission based on the detected scheduling conflict with the TDD subframe reconfiguration.

10. The user equipment of claim 9, wherein the modifying comprises modifying a content of the CSI or the SRS transmission.

11. The user equipment of claim 10, wherein the modifying the content comprises computing a subband for transmitting the CSI or the SRS transmission based on at least one of a TDD subframe configuration before the TDD subframe reconfiguration or a TDD subframe configuration after the TDD subframe reconfiguration.

12. The user equipment of claim 9, wherein the modifying comprises modifying a rank indicator (RI) or a precoding type indicator (PTI) related to the CSI or the SRS transmission.

13. The user equipment of claim 12, wherein the modifying the RI or the PTI comprises using at least one of a previous RI or PTI from a TDD subframe configuration before the TDD subframe reconfiguration, a previous RI or PTI from a TDD subframe configuration after the TDD subframe reconfiguration, a common RI or PTI for the TDD subframe reconfiguration, or a lowest allowed RI or PTI.

14. The user equipment of claim 9, wherein the modifying comprises selecting the next TDD subframe reconfiguration in a set of received TDD subframe reconfigurations based on detecting the conflict between the CSI or the SRS transmission and the TDD subframe reconfiguration.

15. The user equipment of claim 9, wherein the means for modifying comprises:

means for detecting the different TDD subframe reconfiguration for the data transmission; and

means for modifying the data transmission based on the different TDD subframe reconfiguration.

16. A user equipment for configuring control data communications based on a time division duplexing (TDD) subframe reconfiguration, comprising:

a memory; and

at least one processor coupled to the memory and configured to:

detect a TDD subframe reconfiguration from a first TDD subframe configuration to a second TDD subframe configuration;

detect a scheduling conflict with a scheduled channel state information (CSI) transmission or a sounding reference signal (SRS) transmission based on the TDD subframe reconfiguration; and

modify at least one aspect of the CSI transmission or the SRS transmission based on the TDD subframe reconfiguration, comprising

modifying a periodicity of the CSI or the SRS transmission of the second TDD subframe configuration, wherein the modifying the periodicity comprises dropping at least one instance of the CSI or SRS transmission based on the detected scheduling conflict with the TDD subframe reconfiguration.

17. The user equipment of claim 16, wherein the modifying comprises modifying a content of the CSI or the SRS transmission.

18. The user equipment of claim 17, wherein the modifying the content comprises computing a subband for transmitting the CSI or the SRS transmission based on at least one of a TDD subframe configuration before the TDD subframe reconfiguration or a TDD subframe configuration after the TDD subframe reconfiguration.

19. The user equipment of claim 16, wherein the modifying comprises modifying a rank indicator (RI) or a precoding type indicator (PTI) related to the CSI or the SRS transmission.

20. The user equipment of claim 19, wherein the modifying the RI or the PTI comprises using at least one of a previous RI or PTI from a TDD subframe configuration before the TDD subframe reconfiguration, a previous RI or PTI from a TDD subframe configuration after the TDD subframe reconfiguration, a common RI or PTI for the TDD subframe reconfiguration, or a lowest allowed RI or PTI.

21. The user equipment of claim 16, wherein the modifying comprises selecting the next TDD subframe recon-

figuration in a set of received TDD subframe reconfigurations based on detecting the conflict between the CSI or the SRS transmission and the TDD subframe reconfiguration.

**22**. The user equipment of claim **16**, wherein the at least one processor is configured to:

detect a different TDD subframe reconfiguration for the data transmission; and

modify the data transmission based on the different TDD subframe reconfiguration.

**23**. A non-transitory computer-readable medium storing computer executable code comprising code for:

detecting a time division duplexing (TDD) subframe reconfiguration from a first TDD subframe configuration to a second TDD subframe configuration;

detecting a scheduling conflict with a scheduled channel state information (CSI) transmission or a sounding reference signal (SRS) transmission based on the TDD subframe reconfiguration; and

modifying at least one aspect of the CSI transmission or the SRS transmission based on the TDD subframe reconfiguration, including at least one of

modifying a periodicity of the CSI or the SRS transmission of the second TDD subframe configuration, wherein the modifying the periodicity comprises dropping at least one instance of the CSI or SRS transmission based on the detected scheduling conflict with the TDD subframe reconfiguration.

**24**. The computer-readable medium of claim **23**, wherein the modifying comprises modifying a content of the CSI or the SRS transmission.

**25**. The computer-readable medium of claim **24**, wherein the modifying the content comprises computing a subband for transmitting the CSI or the SRS transmission based on at least one of a TDD subframe configuration before the TDD subframe reconfiguration or a TDD subframe configuration after the TDD subframe reconfiguration.

**26**. The computer-readable medium of claim **23**, wherein the modifying comprises modifying a rank indicator (RI) or a precoding type indicator (PTI) related to the CSI or the SRS transmission.

**27**. The computer-readable medium of claim **26**, wherein the modifying the RI or the PTI comprises using at least one of a previous RI or PTI from a TDD subframe configuration before the TDD subframe reconfiguration, a previous RI or PTI from a TDD subframe configuration after the TDD subframe reconfiguration, a common RI or PTI for the TDD subframe reconfiguration, or a lowest allowed RI or PTI.

**28**. The computer-readable medium of claim **23**, wherein the modifying comprises selecting the next TDD subframe reconfiguration in a set of received TDD subframe reconfigurations based on detecting the conflict between the CSI or the SRS transmission and the TDD subframe reconfiguration.

**29**. The computer-readable medium of claim **23**, wherein the modifying comprises:

detecting the different TDD subframe reconfiguration for the data transmission; and

modifying the data transmission based on the different TDD subframe reconfiguration.

**30**. The method of claim **1**, wherein a TDD subframe reconfiguration includes changing from a first TDD subframe configuration to a second TDD subframe configuration.

**31**. The method of claim **30**, further comprising:

detecting a scheduling conflict between a first SRS transmission scheduled based on the first TDD subframe configuration and a second SRS transmission scheduled based on the second TDD subframe configuration; and

modifying the periodicity of the SRS transmission, wherein the modifying the periodicity comprises dropping at least one instance of the SRS transmission based on the detected scheduling conflict with the TDD subframe reconfiguration.

**32**. The method of claim **30**, further comprising:

detecting a scheduling conflict between a first CSI transmission scheduled based on the first TDD subframe configuration and a second CSI transmission scheduled based on the second TDD subframe configuration; and

modifying the periodicity of the CSI transmission, wherein the modifying the periodicity comprises dropping at least one instance of the CSI transmission based on the detected scheduling conflict with the TDD subframe reconfiguration.

**33**. The apparatus of claim **9**, wherein the modifying the periodicity further comprises utilizing a configuration corresponding to a next lowest or highest configuration index related to the CSI or the SRS transmission.

**34**. The apparatus of claim **16**, wherein the modifying the periodicity further comprises utilizing a configuration corresponding to a next lowest or highest configuration index related to the CSI or the SRS transmission.

**35**. The computer-readable medium of claim **23**, wherein the modifying the periodicity further comprises utilizing a configuration corresponding to a next lowest or highest configuration index related to the CSI or the SRS transmission.

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